

AIR QUALITY
MONITORING PROGRAM
FOR THE
TOWN OF KAPUSKASING

1974-84

NER-AQTM-09-85

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Ministry
of the
Environment

Ontario

W.J. GIBSON, Director
Northeastern Region

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Air Quality Monitoring Program
for the Town of Kapuskasing

1974-84

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NER-AQTM-09-85

Ontario Ministry of the Environment
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I Summary

Ambient air quality monitoring has been carried out by the Ontario Ministry of the Environment in the Town of Kapuskasing since 1977, when a sulphation plate network was installed to monitor sulphation rate during the growing season. Results of this survey indicate the sulphation rate has been within acceptable limits since 1981. A dustfall monitoring network was commissioned in the Town in 1980. Results of this survey indicate that wood material (wood char, wood chips, wood material) regularly exceed the Provincial criteria at three of the four locations.

Vegetation and soil sampling was carried out in the vicinity of the Spruce Falls Power and Paper Co. Ltd. mill in 1975, 1976 and 1983. Elevated calcium (and to a lesser extent, magnesium) concentrations in balsam poplar were recorded in 1975 but these decreased in subsequent collections. Values for other elements including sodium, sulphur, chloride, iron, copper, lead and zinc were mostly within the normal range for the respective elements. Values of the different elements in the soil were quite variable from location to location and from year to year; however, it can be concluded that soils in the area have relatively high natural calcium, magnesium and iron content.

A snow sampling program, conducted in 1975 in the vicinity of the Spruce Falls Power and Paper Co. Ltd. mill, demonstrated the presence of a contamination zone of calcium, sodium, sulphate, chloride and aluminum. The contamination zone was confined to a 400 m radius of the paper mill.

II Introduction

In 1920, the Spruce Falls Company constructed a pulp mill on the Kapuskasing River at the present Town of Kapuskasing. The Company was able to take advantage of several factors including vast stands of timber, several major rivers for delivering logs to the mill, a waterfall where electrical power could be generated and a rail connection for shipping their products to southern markets. The original calcium-based sulphite mill produced 115 tons/day of unbleached sulphite pulp.

In 1928, a new company named the Spruce Falls Power and Paper Company Ltd. was formed and began a program of expansion to 650 tons/day with four newsprint machines and eight digesters. A magnesite mill was constructed in 1964, updated in the late 1970s and early 1980s as part of a major rebuild program. In 1982, calcium sulphite furnish was totally replaced with magnesium-based pulp from the magnesite mill.

A stud mill, operated east of the main mill complex, produces 50 million board feet of lumber per year and supplies chips to the main mill and hogged fuel to the power boilers.

The present report is a summary of the investigations of the air quality monitoring programs carried out by the Ontario Ministry of the Environment since 1974.

III Air Quality Monitoring Program

Air quality has been monitored in the Town of Kapuskasing since May of 1977 when a summer (May to September) sulphation program was initiated and six sulphation plates were located in the Town. This summer sulphation program has continued through 1984. In addition to the summer sulphation program, a dustfall monitoring program began in August of 1980 when four dustfall jars were installed at Highway 11, McPherson Avenue, Riverside Drive and Mill Street. Locations of sulphation plates and dustfall monitors can be seen in Figure 1 and are listed in Table 1.

i) Sulphation

An outline of the technique used to measure sulphation rate is included in Appendix B. A summary of sulphation data collected in the Town of Kapuskasing from 1977 to 1984 is presented in Table 2. Results of each individual sampling location are shown in Tables 3 to 8 and Figures 2 to 7.

The number of monthly samples above the Provincial Criterion of $0.7 \text{ mg SO}_3/100 \text{ cm}^2/\text{day}$ (30-day period) is variable ranging from a high of 4 at McPherson Avenue in 1977 to none at most locations from 1981 to 1984. Generally, the rate of sulphation has decreased or remained low at all monitoring sites in Kapuskasing during the 1981-1984 period. Only one exceedence of the Provincial Criterion was observed in 1984 (McPherson Avenue).

The number of exceedences of the monthly criterion ranged from 5 in 1977 to 0 in 1981, 1982 and 1983.

Although a decrease in sulphur dioxide was expected because of the modifications made to the mill late in 1982, it is difficult to tie this decrease in sulphation rate in with any physical or operational changes made during that period.

ii) Dustfall

A description of the dustfall monitoring techniques is included in Appendix A. Summaries of total dustfall levels collected in the Town of Kapuskasing from 1980 to 1982 are presented in Tables 9 to 13 and Figures 8 to 11. Results of microscopic examination are summarized in Table 14.

Results of the dustfall survey, carried out in the Town of Kapuskasing from August, 1980, to 1984, indicate that both annual and monthly dustfall regularly exceed the Ontario Ministry of the Environment's criteria at three of the four sampling locations. The majority of the settleable particulate is a result of wood material such as chips, sawdust and char with the remainder being generated by vehicular traffic and construction activity.

Annual mean dustfall values fluctuated above and below the Provincial criterion of $4.5 \text{ g/m}^3/30 \text{ days}$ (yearly mean) south of Hwy. 11 (72059) from 1980 to 1984. A substantial decrease

in mean dustfall level was observed at McPherson Avenue (72060) from 1980 to 1981, although levels still remained above the criterion. Mean dustfall values have consistently exceeded the yearly criterion at Riverside Drive (72061). Mean values have been consistently below the Provincial criterion at Mill Street (72062) since the jar was installed in 1980.

The Ontario Ministry of the Environment's monthly Criterion of $7.0 \text{ g/m}^2/30$ days was also regularly exceeded at the site south of Hwy. 11 (6 times), McPherson (24 times) and Riverside Drive (33 times) from 1980 to 1984. The monthly criterion was exceeded at Mill Street on only one occasion during the same period.

The yearly criterion of $4.5 \text{ g/m}^2/30$ days was regularly exceeded at three of the four locations from 1981 to 1984. The yearly criterion was not exceeded at Mill Street since the program began.

Results of microscopic examination of dustfall samples are presented in Table 14. Results show a high percentage of wood material, (wood char, wood chips, wood material) in the majority of samples examined. The yearly mean percentage of wood material observed in samples varied from 53% to 92% with the majority of samples containing over 60% wood material. The mean percentage of wood material decreased at McPherson Avenue, Riverside Drive and Mill Street from 1980 to 1984; while south of Highway 11, the mean value decreased in 1983

then returned to 1980 levels in 1984. The remainder of the particulate collected in the dustfall samples can be attributed to dusting from sources such as roads and construction sites.

iii) Future Monitoring Program

The Ontario Ministry of the Environment will continue to monitor total dustfall in Kapuskasing using the dustfall jar technique. The Mill Street monitor will be relocated near the downtown section. The sulphation monitoring network was discontinued in 1985 since levels showed a significant decrease after 1981.

Sulphur dioxide monitoring will be considered if complaints are received from the public in the future.

IV Vegetation and Soil Sampling Program

i) Survey Methods

In June, 1984, a preliminary investigation of the Kapuskasing area was undertaken. At that time, three locations were selected for collection of vegetation samples (Figure 12). Samples of trembling aspen foliage and forage (grass mixture) were collected for chemical analysis at each location. The samples were subsequently divided into two portions, one of which was washed to remove any external particulate contaminants. The samples were then analyzed to determine the sulphur, calcium and sodium content.

In early September, 1975, the sampling program in the area was expanded to include eight stations around the paper mill (Figure 13). A ninth station was added in 1976. The stations were established at the following locations.

<u>Station No.</u>	<u>Location</u>
1	900 m west
2	1,600 m west
3	250 m north
4	1,300 m north
5	2,400 m north northeast
6	1,200 m east northeast
7	2,000 m east northeast
8	200 m southeast
9	900 m east southeast

In 1975, 1976 and 1983, triplicate samples of balsam poplar foliage and soil (0-10 cm) were collected at each station.

The samples were returned to the laboratory and processed for chemical analysis. The foliage samples were oven-dried, ground in a Wiley mill and bottled. The soil samples were air-dried, ground in a mortar and pestle to pass through a 45 mesh sieve and bottled. The samples were then forwarded to the Ministry's laboratory in Toronto for analysis. The analyses included calcium, sodium, magnesium (soil only in 1975), chloride and sulphur. In 1975, the samples were also analyzed for their iron, copper, lead and zinc content.

ii) Background Concentration Limits

The Ontario Ministry of the Environment has conducted numerous vegetation and soil sampling programs throughout the Province of Ontario. Based on experience with these programs as well as on data published in the literature, a set of values has been developed to indicate the concentrations of individual chemical elements which are considered to be above background concentrations. The values were determined by statistically evaluating data for the Northeast Region using only samples from uncontaminated sites. The values presented in the table below would be encountered no more than once in 100 samples on a statistical basis. Values presented do not necessarily mean that there is toxicity involved but indicate that there is evidence of contamination above average normal levels. The concentration limits of elements in vegetation or soil are considered to be tools for use by phytotoxicology

investigators in interpreting the results of chemical analyses. Certain limitations exist with these established levels, and investigators must judge their use in supplementing other results and observations from field assessment surveys. The following values are used in this report:

<u>Element</u>	<u>Soil</u>	<u>Foliage</u>	<u>Forage</u>
Calcium	3%	3,000 ug/g	-
Magnesium	1%	.7%	-
Sodium	-	50 ug/g	-
Chloride	-	.15%	1%
Sulphur	.1%	.4%	.5%
Iron	3.5%	500 ug/g	-
Copper	60 ug/g	20 ug/g	-
Lead	150 ug/g	30 ug/g	-
Zinc	500 ug/g	-	-

iii) Analytical Results

The analytical results of the 1974 collection of vegetation are shown in Tables 15 and 16. The concentrations of sulphur and calcium in both vegetation species were within their normal respective concentration ranges. The only differences between washed and unwashed samples occurred at location 1 (200 m north of the paper mill) where the unwashed samples contained more of these elements (sulphur only in aspen). The sodium content of aspen foliage at Site 1 and forage at Site 2 marginally exceeded the Background Concentration Limit of 350 ug/g for sodium.

The results of the chemical analyses conducted in 1975 to 1983 are presented in Tables 17 to 22. Calcium values for seven of the eight foliage samples exceeded the Background Concentration Limits for this element in foliage in 1975 (Table 17). The higher values were generally found nearest to the paper mill. The concentrations were lower in 1976 and decreased still further in 1983.

The calcium content of the soil was quite variable from year to year, especially at Sites 3, 4, 6 and 7 where localized areas of high concentrations of calcium were encountered (Table 17). There is no indication that the high concentrations were associated with any possible emissions from the paper mill.

The magnesium content of balsam poplar foliage decreased between 1976 and 1983, but, in all cases, the concentrations were within the normal range (Table 18). The Background Concentration Limits were exceeded at six locations for magnesium in soil, indicating that the soils of the area are naturally high in this element.

There are no evident trends with respect to time or location in the concentrations of sodium or chloride measured in the samples (Table 19 and 20). The sample of balsam poplar foliage which exceeded the Background Concentration Limit for sulphur was collected in 1975 at Site 1 (Table 21). By contrast, soil samples at six sites exceeded the Background

Concentration Limit for sulphur. Concentrations of sulphur decreased in 1976 and further in 1983. The highest values were found at Sites 2 and 7 which are among the more distant from the paper mill; therefore, the source of the elevated sulphur values is unknown.

The concentrations of iron, copper, lead and zinc were found to be within the normal range for balsam poplar (Table 22). This species is a natural accumulator for zinc, therefore, the values for zinc were greater than for most other plant species. The iron content for the soil was relatively high and at two locations (Sites 6 and 8), the values exceeded the Background Concentration Limit of 3.5% iron. The concentrations of the other elements in soil were within their normal range, with the exception of copper at Site 1. This would appear to be a localized area of elevated copper content.

iv) Injury to Vegetation

In July, 1976, an area of injury to vegetation in the Town Park between McPherson Avenue and the Kapuskasing River was discovered. The area of injury was mapped out (Figure 14). Most injury symptoms were apparent as intercostal necrosis (dead tissue between veins of leaves) typical of acute SO₂ fumigation injury. The most severely injured species included white birch, white ash, red-osier dogwood, paeony, currant, willow, cedar and balsam poplar.

During monthly visits to Kapuskasing in succeeding growing seasons, surveys of injury to vegetation were carried out. The locations of injury to vegetation were mapped out and the severity of injury of different species was recorded.

Injury to vegetation, similar to that observed in 1976, was discovered each year from 1977 to 1980 (Figures 15 to 18).

The areas with injury were generally located directly north of the paper mill and involved the same plant species as noted in 1976. Severity of the injury varied from year to year. No injury was recorded after 1980.

V Snow Sampling Study

i) Survey Methods

The first collection of snow samples was made on January 14, 1975, at a total of 15 locations along radii to the east, southeast, south, southwest, west, northwest and north up to 1,600 m from the paper mill. Snow at a single control site 8 km west of Kapuskasing was also collected. The second collection of snow samples was made on February 5, 1975, and the number of collections around the paper mill was increased to 22 locations. The locations of the sample sites are shown in Figure 19.

At each sample location, five circular cores of snow (18 cm deep and 8 cm in diameter) were collected and allowed to melt overnight at room temperature. The five snow melt water samples were then combined and a pH measurement taken immediately. Each sample was then divided into two equal portions and one of these portions was preserved by the addition of 2 ml of nitric acid. The acidified portion of the sample was analyzed for Ca, Na and Al, while the sulphate and chloride concentrations were determined from the non-acidified portion.

ii) Background Concentration Limits

Background Concentration Limits for elements in snow have been established in the same manner as those for soil and vegetation, as described earlier in this report. The values which relate to this report are as follows.

<u>Element</u>	<u>Background Concentration Limit (mg/L)</u>
Sulphate	3
Chloride	4
Calcium	2
Sodium	2
Aluminum	.6

iii) Analytical Results

The analytical results of the snow samples are summarized in Table 23. The concentrations of all elements were elevated near the mill and decreased with increasing distance from the mill.

Sulphate concentrations exceeded the Background Concentration Limit of 3 mg/L SO_4 at ten locations for at least one of the sample collection periods. By contrast, chloride values were greater than background in only one sample collection at three locations (Sites 7, 15 and 19). Aluminum and calcium concentrations showed similar patterns in that all samples, except the February collections at Site 12 and the control location, exceeded the Background Concentration Limit. The sodium values exceeded the background levels at six locations

on one or more occasions, however, the elevated values encountered at Sites 3, 7, 8 and 18 were not considered to be associated with the paper mill. The pH values ranged from 6.00 to 6.80, which were relatively high for precipitation. It is suggested that particulate material associated with emissions from the paper mill were responsible for buffering the pH to higher values. There was no evident pattern of snow pH values with respect to the location of the paper mill.

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APPENDIX A

TABLE 1

Air monitoring locations and parameters monitored in Kapuskasing
from 1977 to 1984

Station	Location	Pollutants Monitored		Installed
		SO _x	D	
72050	McPherson Avenue, House #2	X		May 1977
72051	Hall and Aurora Avenue	X		May 1977
72052	Ash Street	X		May 1977
72053	Brunelle Avenue/Brunetville Road	X		May 1977
72054	De Letang Avenue	X		May 1977
72055	Dominion Experimental Farm	X		May 1977
72059	South of Highway 11 West of Bridge		X	August 1980
72060	2 McPherson Avenue		X	August 1980
72061	4 Riverside Drive		X	August 1980
72062	Closed Section of Mill Street West		X	August 1980

Note: D - Dustfall
SO_x - Sulphation Rate

TABLE 2

Annual summary of sulphation rate on lead peroxide plates in Kapuskasing from May, 1977, to September, 1984

Location	Number of Samples Collected								Arithmetic Mean (mg/100 cm ² /day)							
	1977	1978	1979	1980	1981	1982	1983	1984	1977	1978	1979	1980	1981	1982	1983	1984
2 McPherson Avenue (72050)	5	3	4	3	3	3	4	2	1.27	0.72	1.16	0.78	0.23	0.32	0.29	0.46
Hall and Aurora Avenue (72051)	5	3	4	2	4	3	3	2	0.21	0.11	0.12	0.13	0.26	0.07	0.05	0.05
Ash Street (72052)	5	2	4	3	4	3	4	2	0.27	0.42	0.22	0.17	0.04	0.09	0.13	0.12
Brunelle Avenue (72053)	5	3	4	2	4	3	4	2	0.30	0.23	0.30	0.35	0.09	0.09	0.21	0.14
De Letang Avenue (72054)	5	3	4	2	4	3	4	2	0.64	0.39	0.51	0.45	0.13	0.16	0.21	0.31
Dominion Experimental Farm (72055)	4	3	4	2	4	3	4	2	0.28	0.28	0.17	0.15	0.14	0.06	0.09	0.05
TOTAL	29	17	24	14	23	18	23	12								

TABLE 2 (continued)

[illegible]

TABLE 3

Level of sulphation on lead peroxide plates at Station 72050
McPherson Avenue in the Town of Kapuskasing
from 1977 to 1984

(milligrams of $\text{SO}_3/100 \text{ cm}^2/\text{day}$)

Year	May	June	July	Aug.	Sep t.	Mean
1977	.59	<u>2.17</u>	<u>.92</u>	<u>1.57</u>	<u>1.08</u>	1.27
1978	-	.17	<u>1.13</u>	<u>.86</u>	-	.72
1979	<u>2.08</u>	.40	<u>1.27</u>	-	<u>.95</u>	1.16
1980	-	.28	<u>.91</u>	-	<u>1.16</u>	.78
1981	-	-	.20	.08	.42	.23
1982	.63	.15	.17	-	-	.32
1983	-	.70	.17	.15	.12	.29
1984	-	-	.15	.46*	<u>.77</u>	.46

Note: - Indicates missing or invalid data
Underlined values exceeded Provincial Criterion
0.7 mg $\text{SO}_3/100 \text{ cm}^2/\text{day}$ (30-day period)
* August, 1984, calculated by averaging July - August
data with August - September data

TABLE 4

Level of sulphation on lead peroxide plates at Station 72051
Hall and Aurora Avenue in the Town of Kapuskasing
from 1977 to 1984

(milligrams of $\text{SO}_3/100 \text{ cm}^2/\text{day}$)

Year	May	June	July	Aug.	Sept.	Mean
1977	.18	.31	.31	.11	.12	.21
1978	-	.06	.08	.19	-	.11
1979	.21	.06	.12	-	0.10	.12
1980	-	.05	.21	-	-	.13
1981	-	.15	.63	.19	.07	.26
1982	.17	0	.05	-	-	.07
1983	-	-	.06	<.05	<.05	.06
1984	-	-	<.05	0.5*	.05	0.05

Note: - Indicates missing or invalid data
Underlined values exceeded Provincial Criterion
0.7 mg $\text{SO}_3/100 \text{ cm}^2/\text{day}$ (30-day period)
* August, 1984, calculated by averaging July - August
data with August - September data

TABLE 5

Level of Sulphation on lead peroxide plates at Station 72052
Ash Street in the Town of Kapuskasing
from 1977 to 1984

(milligrams of $\text{SO}_3/100 \text{ cm}^2/\text{day}$)

Year	May	June	July	Aug.	Sept.	Mean
1977	.19	.55	.31	.17	.12	.27
1978	-	-	.56	.28	-	.42
1979	.17	.27	.18	-	.27	.22
1980	-	.18	.21	-	.13	.17
1981	-	.05	.09	0	0	.04
1982	.08	.10	.08	-	-	.09
1983	-	.16	.10	.13	.13	.13
1984	-	-	<.05	.12*	.18	.12

Note: - Indicates missing or invalid data
Underlined values exceeded Provincial Criterion
0.7 mg $\text{SO}_3/100 \text{ cm}^2/\text{day}$ (30-day period)
* August, 1984, calculated by averaging July - August
data with August - September data

TABLE 6

Level of sulphation on lead peroxide plates at Station 72053
Brunelle Avenue in the Town of Kapuskasing
from 1977 to 1984

(milligrams of SO₃/100 cm²/day)

Year	May	June	July	Aug.	Sept.	Mean
1977	.34	.44	.43	.17	.10	.30
1978	-	.25	.21	.22	-	.23
1979	.20	.45	.26	-	.28	.30
1980	-	.22	.48	-	-	.35
1981	-	.11	.14	.05	.06	.09
1982	.10	.06	.12	-	-	.09
1983	-	.27	.24	-	-	.21
1984	-	-	.12	.14*	.15	.14

Note: - Indicates missing or invalid data
Underlined values exceeded Provincial Criterion
0.7 mg SO₃/100 cm²/day (30-day period)
* August, 1984, calculated by averaging July - August
data with August - September data

TABLE 7

Level of sulphation on lead peroxide plates at Station 72054
de Letang Avenue in the Town of Kapuskasing
from 1977 to 1984

(milligrams of SO₃/100 cm²/day)

YEAR	MAY	JUN	JUL	AUG	SEPT	MEAN
1977	.53	.61	.58	1.26	.23	.64
1978	-	.25	1.01	.28	-	.39
1979	.32	.56	.57	-	.59	.51
1980	-	.44	.46	-	-	.45
1981	-	.05	.21	.15	.10	.13
1982	.16	.13	.19	-	-	.16
1983	-	.27	.26	.18	.13	.21
1984	-	-	0.20	.30*	.39	.31

Note: - Indicates missing or invalid data
Underlined values exceeded Provincial Criterion
0.7 mg SO₃/100 cm²/day (30-day period)
* August, 1984, calculated by averaging July - August
data with August - September data

TABLE 8

Level of sulphation on lead peroxide plates at Station 72055
Dominion Experimental Farm in the Town of Kapuskasing
from 1977 to 1983

(milligrams of $\text{SO}_3/100 \text{ cm}^2/\text{day}$)

Year	MAY	June	July	Aug.	Sept.	Mean
1977	.29	-	.44	.08	.31	.28
1978	-	.25	.13	.45	-	.28
1979	.37	.03	.07	-	.21	.17
1980	-	.05	.24	-	-	.15
1981	-	.26	0	.13	.17	.14
1982	.13	0	.05	-	-	.06
1983	-	.19	.05	.06	<.05	0.09
1984	-	-	<.05	.05*	.05	0.05

Note: - Indicates missing or invalid data
Underlined values exceeded Provincial Criterion
0.7 mg $\text{SO}_3/100 \text{ cm}^2/\text{day}$ (30-day period)
* August, 1984, calculated by averaging July - August
data with August - September data

TABLE 9

Annual summary of dustfall data collected in the Town of Kapuskasing
from August, 1980, to December, 1984

Location	<u>Number of Samples Collected</u>					<u>Arithmetic Mean (g/m²/30 days)</u>					<u>Maximum Value (g/m²/30 days)</u>					<u>Number of Samples Above Provincial Criterion</u>					TOTAL
	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984	
South of Hwy. 11 (72059)	5	11	12	10	11	2.2	5.6	3.1	8.3	3.1	4.4	37.1	7.9	34.7	5.7	0	2	1	3	0	6
2 McPherson Avenue (72060)	5	10	12	10	11	22.4	8.4	7.4	8.7	5.2	47.0	19.5	17.1	15.3	8.4	3	5	7	6	3	24
4 Riverside Drive (72061)	5	11	11	9	11	7.4	10.7	10.1	11.8	8.7	11.4	24.2	21.0	18.0	13.2	3	8	8	8	6	33
Mill Street (72062)	5	10	11	8	10	1.7	2.0	2.0	2.0	2.6	2.1	3.9	6.6	4.3	8.0	0	0	0	0	1	1
TOTAL	20	42	46	37	43											6	15	16	17	10	64

Provincial Criterion - 7.0 g/m²/30 days (30 day period)

TABLE 10

Summary of monthly dustfall data collected at Station 72059
 South of Highway 11 in Kapuskasing
 from August, 1980, to December, 1984

(g/m²/30 days)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1980	-	-	-	-	-	-	-	4.4	2.2	2.2	1.9	0.3	2.2
1981	0.2	1.8	-	1.8	3.2	3.1	2.4	<u>8.0</u>	2.0	1.5	1.0	<u>37.1</u>	<u>5.6</u>
1982	2.4	1.0	2.0	3.3	2.5	5.5	4.2	3.0	2.0	1.7	1.3	<u>7.9</u>	3.1
1983	<u>7.9</u>	-	2.9	3.5	2.5	6.3	<u>17.4</u>	3.7	2.9	1.0	<u>34.7</u>	-	<u>8.3</u>
1984	2.9	2.4	1.9	5.2	0.9	2.6	3.4	3.0	-	1.3	4.4	5.7	3.1

- Indicates missing or invalid data

— Underlined values exceed provincial criterion 7.0 g/m²/30 days

TABLE 11

Summary of monthly dustfall data collected at Station 72060
2 McPherson Avenue in Kapuskasing
from August, 1980, to December, 1984

(g/m²/30 days)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1980	-	-	-	-	-	-	-	<u>11.9</u>	<u>47.0</u>	<u>47.0</u>	4.1	2.2	<u>22.4</u>
1981	0.4	3.7	-	<u>15.5</u>	<u>19.5</u>	<u>10.6</u>	6.6	-	6.9	<u>10.6</u>	<u>7.7</u>	2.4	<u>8.4</u>
1982	3.6	4.4	<u>8.1</u>	<u>17.1</u>	<u>9.4</u>	<u>10.2</u>	<u>9.8</u>	5.5	<u>7.7</u>	<u>7.3</u>	3.0	2.6	<u>7.4</u>
1983	2.6	-	<u>12.7</u>	<u>15.3</u>	<u>15.2</u>	<u>8.2</u>	4.5	5.5	<u>7.8</u>	<u>11.6</u>	3.1	-	<u>8.7</u>
1984	4.3	2.3	6.1	1.5	5.5	<u>7.1</u>	<u>7.3</u>	3.5	-	<u>8.4</u>	5.8	5.3	<u>5.2</u>

- Indicates missing or invalid data

— Underlined values exceed provincial criterion 7.0 g/m²/30 days

TABLE 12

Summary of monthly dustfall data collected at Station 72061
4 Riverside Drive in Kapuskasing
from August, 1980, to December, 1984

(g/m²/30 days)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1980	-	-	-	-	-	-	-	<u>11.4</u>	<u>10.6</u>	<u>10.6</u>	3.6	0.9	<u>7.4</u>
1981	1.1	4.7	-	<u>16.0</u>	<u>24.2</u>	<u>17.5</u>	<u>11.0</u>	<u>12.3</u>	<u>8.9</u>	<u>9.3</u>	<u>10.3</u>	2.2	<u>10.7</u>
1982	3.4	4.4	<u>8.8</u>	<u>21.0</u>	<u>12.6</u>	<u>11.5</u>	<u>13.4</u>	<u>12.8</u>	<u>9.2</u>	<u>9.0</u>	4.5	-	<u>10.1</u>
1983	-	-	<u>11.1</u>	<u>16.7</u>	<u>14.1</u>	<u>18.0</u>	1.2	<u>10.3</u>	<u>16.0</u>	<u>11.0</u>	<u>7.5</u>	-	<u>11.8</u>
1984	6.7	5.2	6.5	<u>13.2</u>	<u>9.3</u>	<u>12.0</u>	<u>10.1</u>	<u>9.1</u>	-	6.6	<u>10.0</u>	7.0	<u>8.7</u>

- Indicates missing or invalid data

___ Underlined values exceed provincial criterion 7.0 g/m²/30 days

TABLE 13

Summary of monthly dustfall data collected at Station 72062
 Mill Street in Kapuskasing
 from August, 1980, to December, 1984

(g/m²/30 days)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1980	-	-	-	-	-	-	-	1.8	2.0	2.0	2.1	0.4	1.7
1981	0.1	0.8	-	2.1	1.8	3.9	3.0	3.7	2.8	0.8	-	1.0	2.0
1982	1.2	1.0	1.1	2.8	2.5	-	6.6	2.1	1.6	1.7	1.2	0.4	2.0
1983	0.4	-	1.2	1.6	4.3	1.7	-	4.0	-	1.4	1.3	-	2.0
1984	1.9	0.8	1.1	2.5	1.4	5.1	<u>8.0</u>	2.5	-	-	1.4	1.2	2.6

- Indicates missing or invalid data

— Underlined values exceed provincial criterion 7.0 g/m²/30 days

TABLE 14

Summary of microscopic examination of dustfall samples collected in
Kapusksing from August, 1980, to June, 1984
percentage of material of wood origin*

Location	<u>Number of Samples Examined</u>					<u>Maximum Value (% of Sample Examined)</u>					<u>Mean (% of Sample Examined)</u>				
	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984
South of Hwy. 11 (72059)	2	4	6	6	6	96	95	95	98	97	81	63	70	69	85
2 McPherson Avenue (72060)	2	5	6	7	5	81	95	88	90	94	78	81	70	61	58
4 Riverside Drive (72061)	2	6	5	7	5	92	98	96	89	84	88	81	81	57	57
Mill Street (72062)	2	6	6	4	4	94	98	97	93	60	92	72	60	71	53

Examination using an optical microscope normally carried out on a bi-monthly basis

* material of wood origin consists of wood material, wood char and wood chips

TABLE 15

Concentrations of various chemical elements in
trembling aspen foliage collected in the Kapuskasing area - 1974

Location*	S%		Ca ppm		Na ppm	
	Washed	Not Washed	Washed	Not Washed	Washed	Not Washed
1 200 m N	.24	.24	2400	3200	370	210
2 800 m NW	.21	.21	4070	4280	330	330
3 1000 m NE	.25	.26	2000	2000	230	250

* Distance and direction from Spruce Falls Power and Paper Company

TABLE 16

Concentrations of various chemical elements in
forage collected in the Kapuskasing area - 1974

Location*	S%		Ca ppm		Na ppm	
	Washed	Not Washed	Washed	Not Washed	Washed	Not Washed
1 200 m N	.24	.34	700	770	350	230
2 800 m NW	.20	.20	800	800	360	250
3 1000 m NE	.18	.18	670	700	310	210

* Distance and direction from Spruce Falls Power and Paper Company

TABLE 17

Concentrations of calcium (%) in balsam poplar foliage
and soil in the vicinity of Spruce Falls Power and
Paper Company Ltd. at Kapuskasing
1975 - 1983

Site	Vegetation			Soil		
	1975	1976	1983	1975	1976	1983
1	5.56	2.43	1.51	.64	2.93	1.30
2	2.42	2.53	.84	1.03	1.37	1.20
3	4.86	2.83	1.53	.62	11.2	1.53
4	6.13	1.80	1.20	.72	9.0	6.80
5	4.85	2.10	1.17	.63	.69	1.27
6	3.13	1.63	.77	.73	3.17	.81
7	3.80	2.53	.91	2.13	.98	4.17
8	6.30	2.67	1.11	.66	.62	.86
9	-	1.60	1.34	-	1.07	.87

TABLE 18

Concentrations of magnesium (%) in balsam poplar
foliage and soil in the vicinity of Spruce Falls
Power and Paper Company Ltd. at Kapuskasing
1975 - 1983

Site	Vegetation		1975	Soil	
	1976	1983		1976	1983
1	0.20	.32	1.26	1.31	1.13
2	.39	.24	.71	.42	.89
3	.35	.27	.92	1.99	.75
4	.34	.19	.79	1.93	1.99
5	.26	.22	.69	.35	.70
6	.25	.22	1.21	1.24	.93
7	.41	.31	.76	.46	1.60
8	.37	.26	1.18	.80	1.07
9	.24	.22	-	.78	.97

TABLE 19

Concentrations of sodium (ug/g) in balsam poplar
foliage and soil in the vicinity of Spruce Falls
Power and Paper Company Ltd. at Kapuskasing
1975 - 1983

Site	Vegetation			Soil		
	1975	1976	1983	1975	1976	1983
1	41	27	23	353	97	260
2	25	40	47	230	227	230
3	32	25	17	264	77	157
4	20	44	23	239	104	290
5	16	5	20	253	177	157
6	20	40	10	357	131	223
7	22	33	10	119	141	257
8	12	23	<10	229	213	277
9	-	27	<10	-	187	237

TABLE 20

Concentrations of chloride (%) in balsam poplar
foliage and soil in the vicinity of Spruce Falls
Power and Paper Company Ltd. at Kapuskasing
1975 - 1983

Site	Vegetation			Soil		
	1975	1976	1983	1975	1976	1983
1	.09	.08	.21	<.02	.02	<.01
2	.07	.11	.13	<.02	.02	<.01
3	.07	.10	.07	<.02	.02	<.01
4	.10	.15	.20	.03	.02	<.01
5	.04	.04	.03	<.02	.02	<.01
6	.04	.04	.02	<.02	.02	<.01
7	.04	.04	.31	<.02	.02	.01
8	.03	.03	.02	<.03	.02	.02
9	-	.05	.02	-	.02	.01

TABLE 21

Concentrations of sulphur (%) in balsam poplar
foliage and soil in the vicinity of Spruce Falls
Power and Paper Company Ltd. at Kapuskasing
1975 - 1983

Site	Vegetation			Soil		
	1975	1976	1983	1975	1976	1983
1	.45	0.23	.25	.11	.09	.07
2	.14	.13	.14	.16	.16	.06
3	.37	.25	.40	.15	.05	.05
4	.17	.16	.19	.11	.03	.03
5	.14	.16	.17	.10	.05	.06
6	.30	.39	.25	.11	.05	.04
7	.27	.25	.27	.22	.14	.07
8	.17	.13	.15	.06	.05	.05
9	-	.19	.19	-	.05	.04

TABLE 22

Concentrations of various chemical elements (ug/g) in balsam poplar
foliage and soil (0-10 cm) samples collected in the vicinity of
Spruce Falls Power and Paper Company Ltd.
at Kapuskasing in 1975

Site	Iron (%)	Vegetation Copper	Lead	Zinc	Iron (%)	Soil Copper	Lead	Zinc
1	135	11	12	284	3.40	77	74	130
2	147	5	19	201	2.42	33	50	67
3	168	3	19	291	2.76	28	79	78
4	159	10	18	233	2.14	26	47	57
5	102	7	11	148	1.86	24	30	45
6	110	7	10	197	3.70	34	41	77
7	143	12	18	117	1.63	39	44	39
8	103	9	13	183	3.52	37	37	57

TABLE 23

Concentrations of the various chemical elements in snow melt water
collected in the Kapuskasing Area - 1975

Location		SO ₄ ppm		Cl ppm		Ca ppm		Na ppm		Al ppm		pH Jan.
		Jan.	Feb.	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.	Jan.	Feb.	
1	200 M E	---	3.5	---	1.7	---	8.1	---	.52	---	1.8	---
2	400 M E	3.1	1.8	2.7	1.7	6.2	2.7	1.8	.80	2.8	1.1	6.00
3	800 M E	---	2.0	---	3.8	---	4.1	---	2.70	---	.99	---
4	1600 M E	1.5	2.2	1.7	2.9	10.0	4.7	1.6	1.9	1.3	2.5	6.70
5	200 M SE	3.4	3.9	1.1	1.1	6.3	4.2	1.0	.4	3.5	2.5	6.25
6	400 M SE	2.6	2.3	1.6	1.1	9.7	3.0	1.5	.56	4.5	1.0	6.10
7	800 M SE	2.8	1.8	5.5	.7	6.2	5.4	3.6	.20	4.2	1.8	6.30
8	1600 M SE	---	1.8	---	3.3	---	3.0	---	2.5	---	1.8	---
9	200 M S	2.4	2.9	.86	2.0	11.	9.9	.64	1.3	8.3	2.3	6.70
10	400 M S	---	1.2	---	1.0	---	7.1	---	.32	---	2.0	---
11	800 M S	1.2	1.5	.39	.4	2.2	3.7	.32	.16	1.3	1.4	6.80
12	1600 M S	1.7	1.6	1.6	1.7	2.4	2.0	1.5	1.2	.72	.37	6.75
13	800 M W	---	1.6	---	.9	---	2.1	---	.52	---	.74	---
14	1600 M W	---	1.4	---	.7	---	2.3	---	.46	---	.91	---
15	200 M NW	4.1	4.3	3.4	7.0	7.8	7.6	2.3	4.10	4.0	1.2	6.30
16	400 M NW	1.2	4.0	1.3	1.8	7.8	6.1	1.2	.94	2.7	.38	6.05
17	800 M NW	2.0	4.5	1.0	2.4	7.0	6.2	.94	1.30	1.8	.40	6.35
18	1200 M NW	1.1	3.5	3.2	1.7	4.1	4.9	2.1	.84	1.9	3.5	6.35
19	200 M N	8.5	6.1	3.0	13.0	12.0	12.0	1.7	8.1	1.6	2.3	6.70
20	400 M N	9.1	4.0	2.8	3.1	7.5	6.3	1.5	1.5	2.8	1.3	6.40
21	800 M N	---	1.9	---	2.0	---	2.6	---	1.3	---	1.1	---
22	1600 M N	4.4	1.7	2.0	.6	4.9	2.3	1.8	.24	.58	1.1	6.75
23	8000 M W Control	.8	.6	3.2	5.1	2.3	.92	2.0	1.3	.69	.4	---

* Distance and direction from Spruce Falls Power and Paper Company

APPENDIX B

KAPUSKASING

- SULPHATION PLATE LOCATION
- DUSTFALL JAR

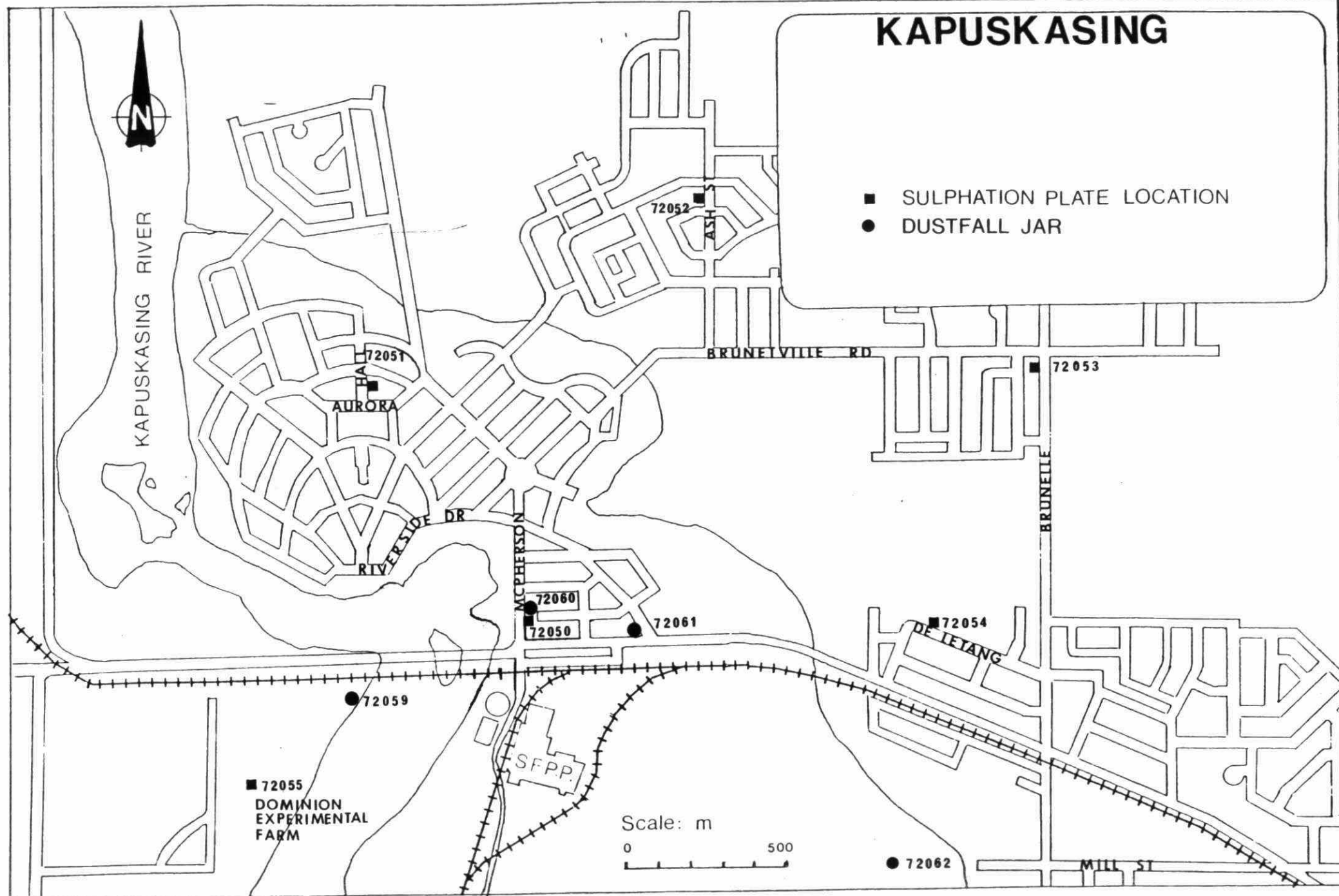


FIGURE 1

MEAN SULPHATION RATE (MAY TO SEPTEMBER)
AT 2 McPHERSON AVENUE, STATION 72050
KAPUSKASING FROM 1977 TO 1984

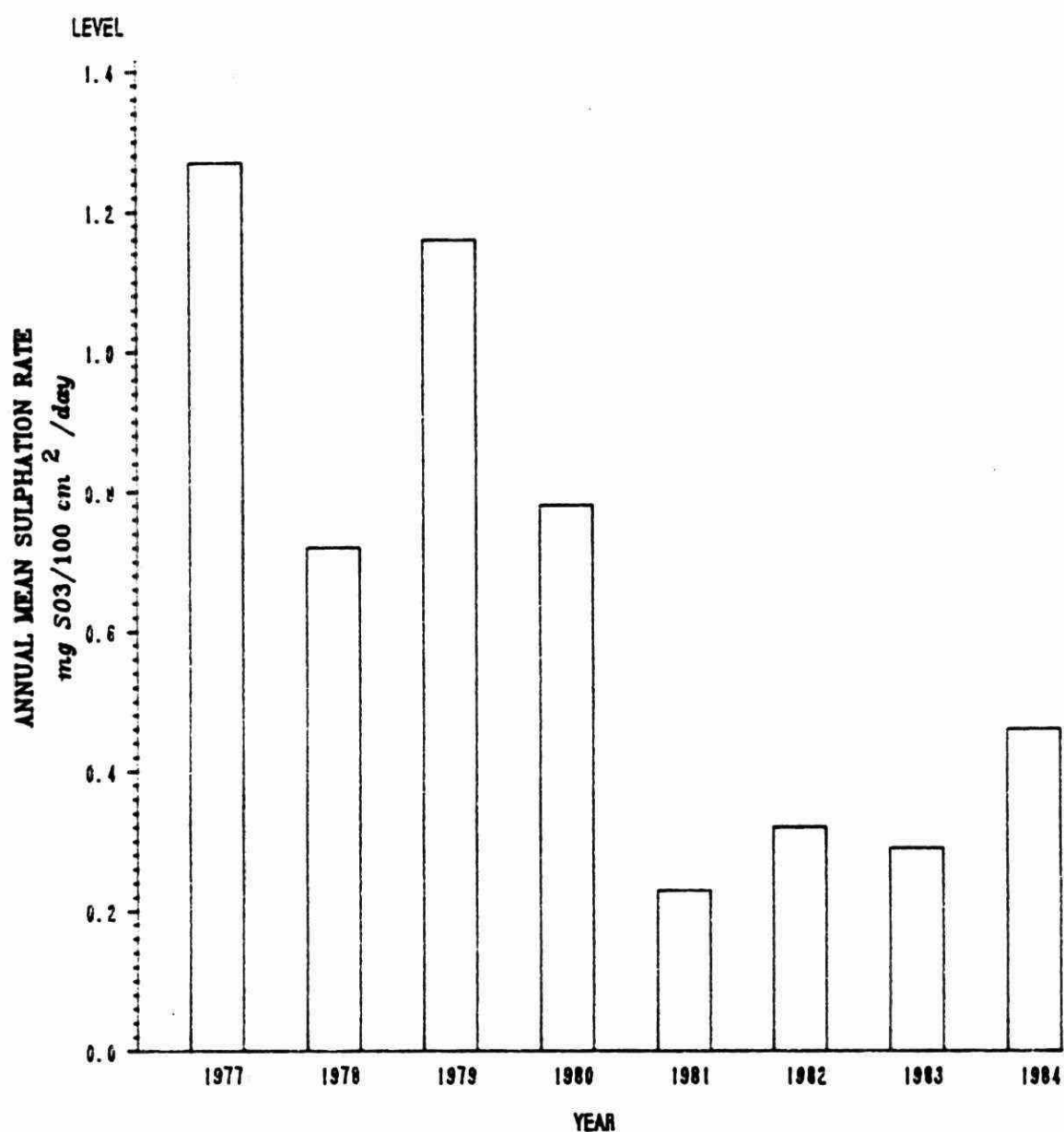


FIGURE 2

MEAN SULPHATION RATE (MAY TO SEPTEMBER)
AT HALL AND AURORA AVENUE, STATION 72051
KAPUSKASING FROM 1977 TO 1984

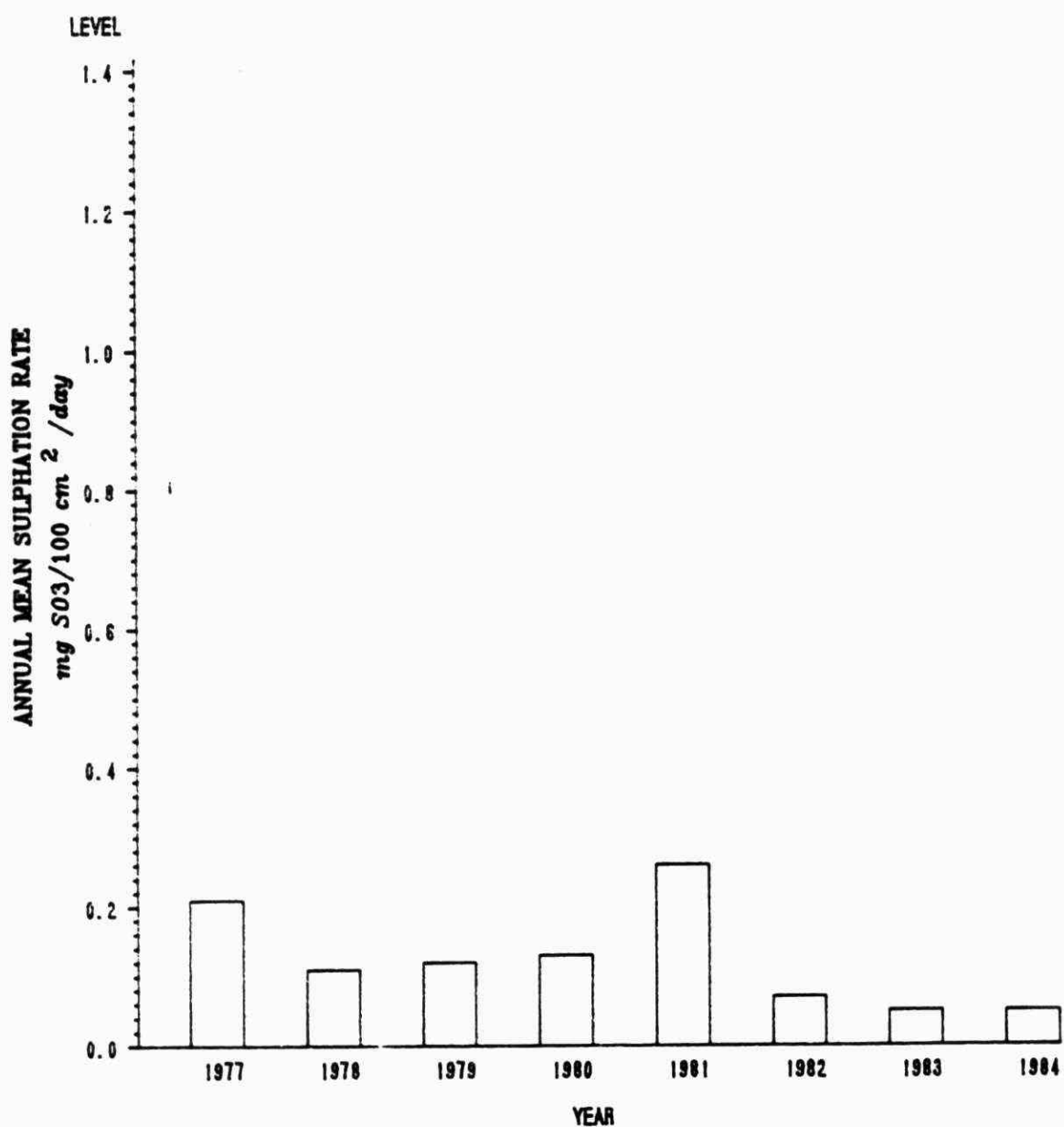


FIGURE 3

MEAN SULPHATION RATE (MAY TO SEPTEMBER)
AT ASH STREET, STATION 72052
KAPUSKASING FROM 1977 TO 1984

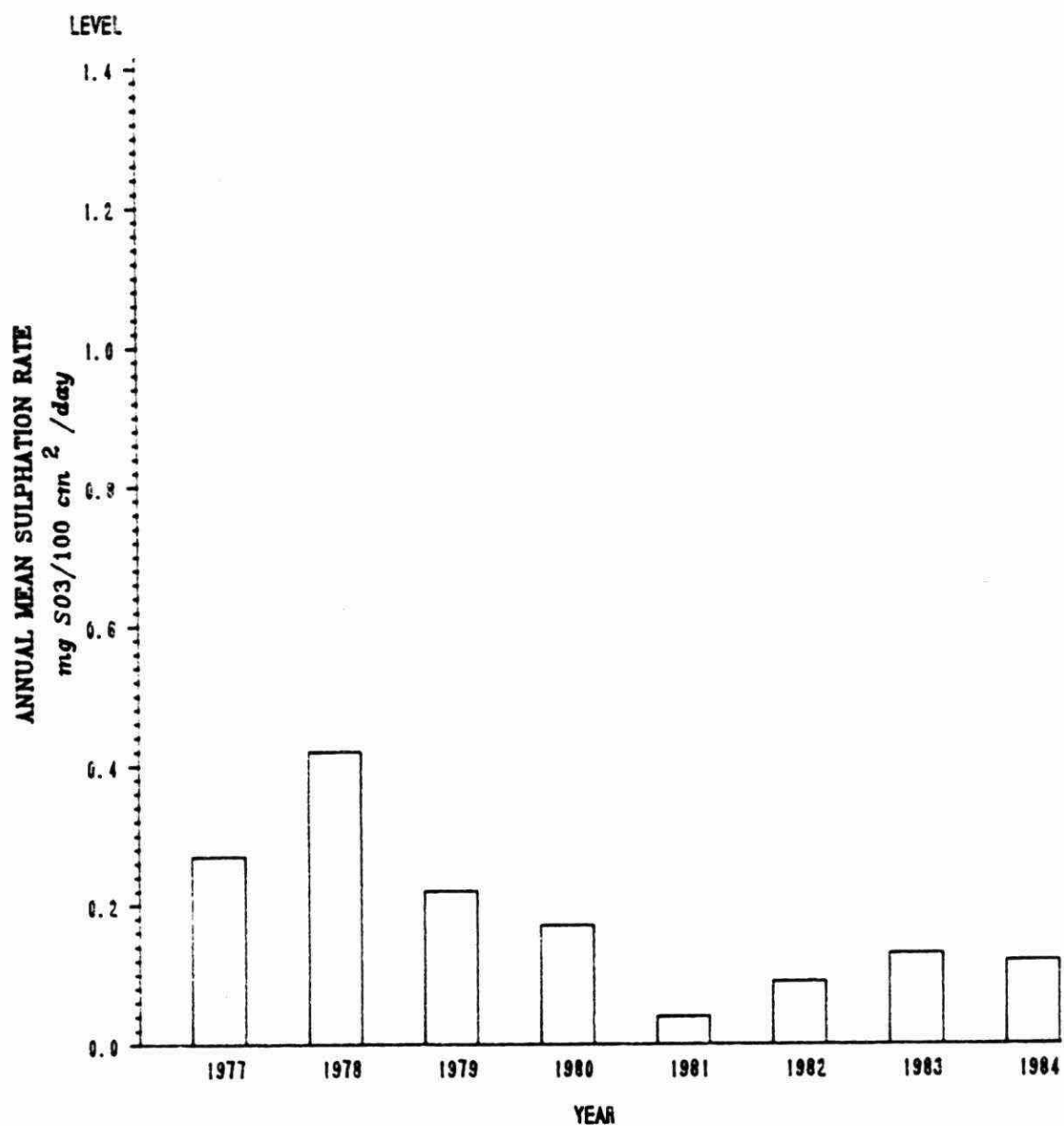


FIGURE 4

MEAN SULPHATION RATE (MAY TO SEPTEMBER)
AT BRUNELLE AVENUE, STATION 72053
KAPUSKASING FROM 1977 TO 1984

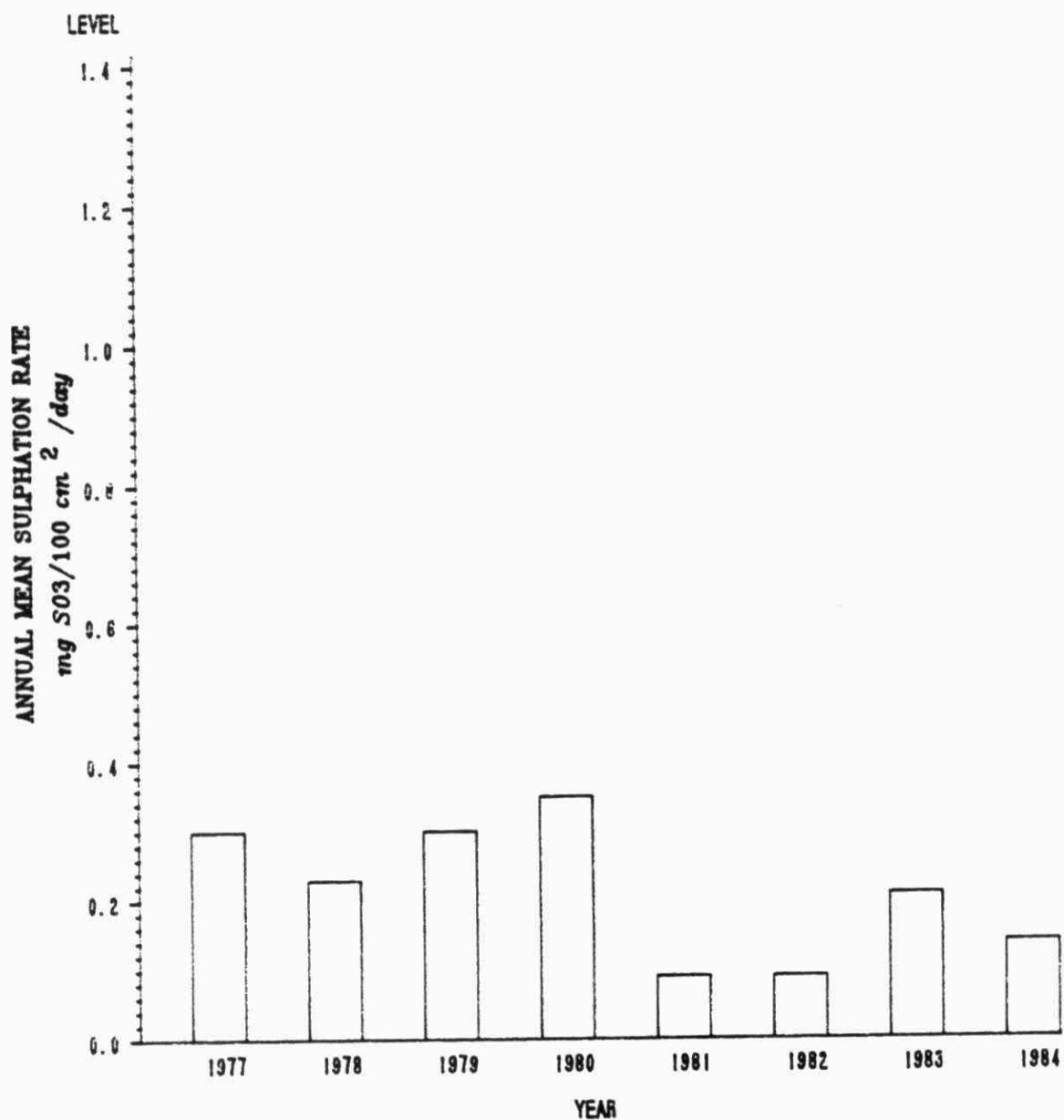


FIGURE 5

MEAN SULPHATION RATE (MAY TO SEPTEMBER)
AT DE LETANG AVENUE, STATION 72054
KAPUSKASING FROM 1977 TO 1984

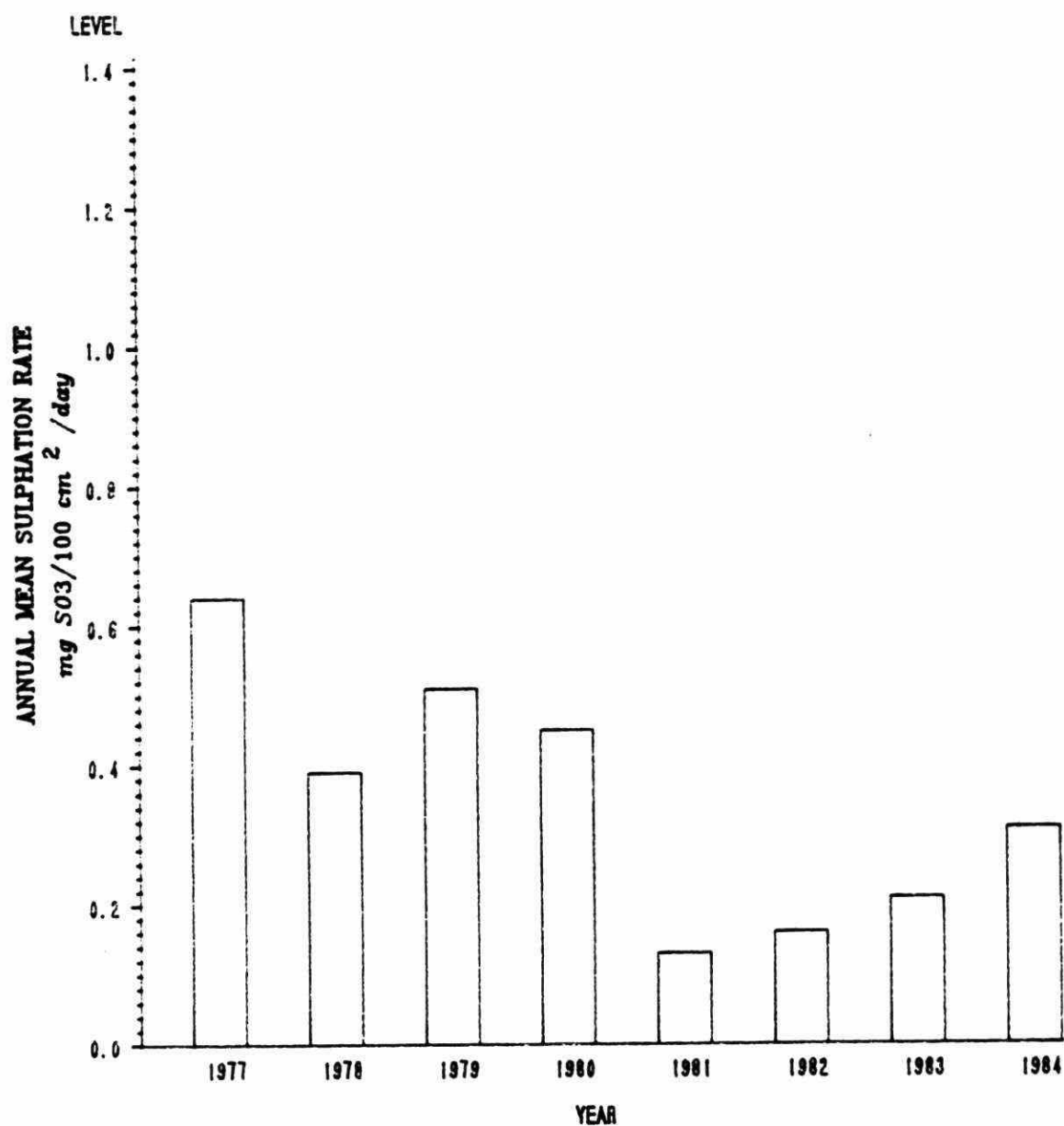


FIGURE 6

MEAN SULPHATION RATE (MAY TO SEPTEMBER)
AT DOMINION EXPERIMENTAL FARM, STATION
72055 KAPUSKASING FROM 1977 TO 1984

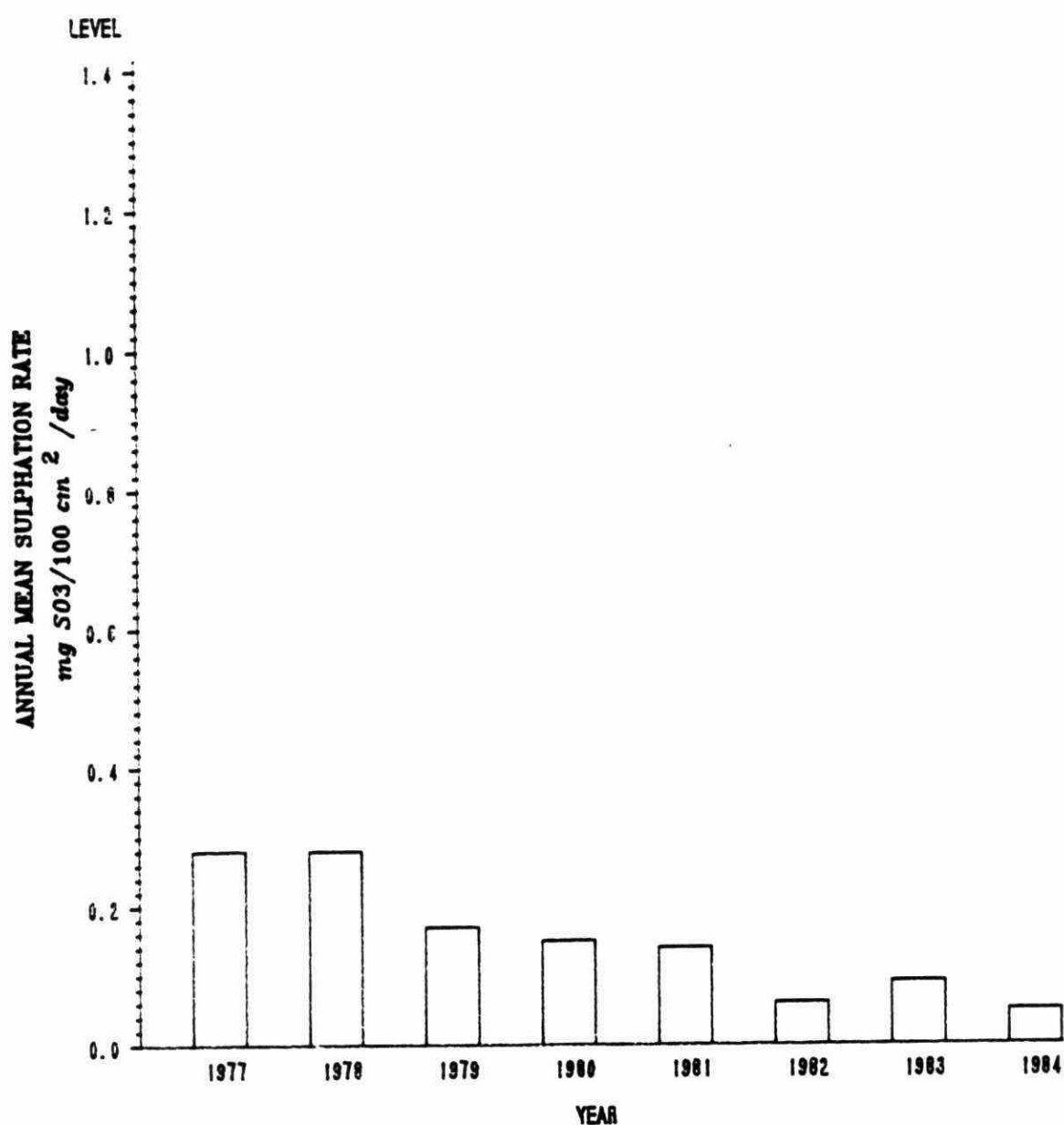
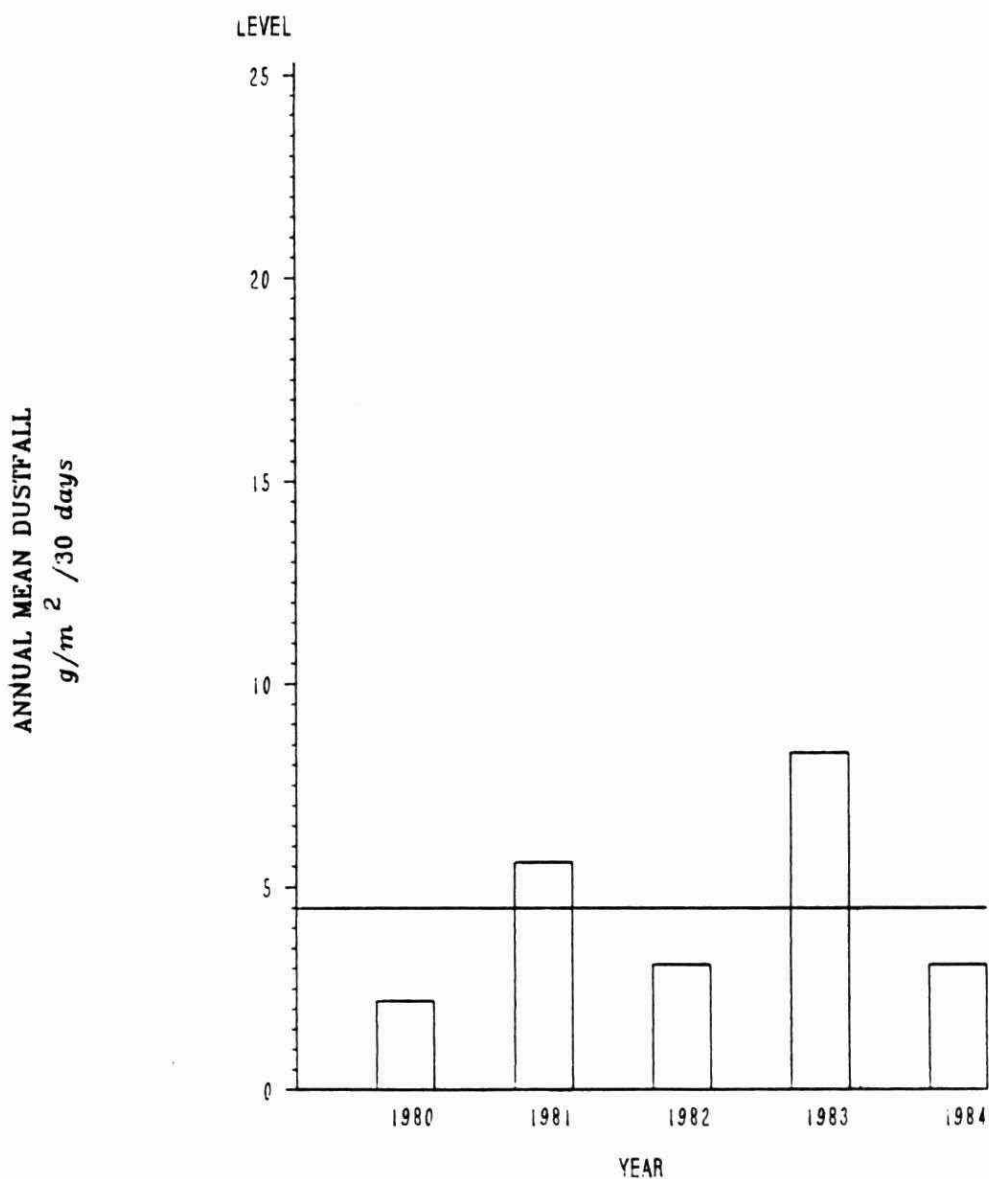


FIGURE 7

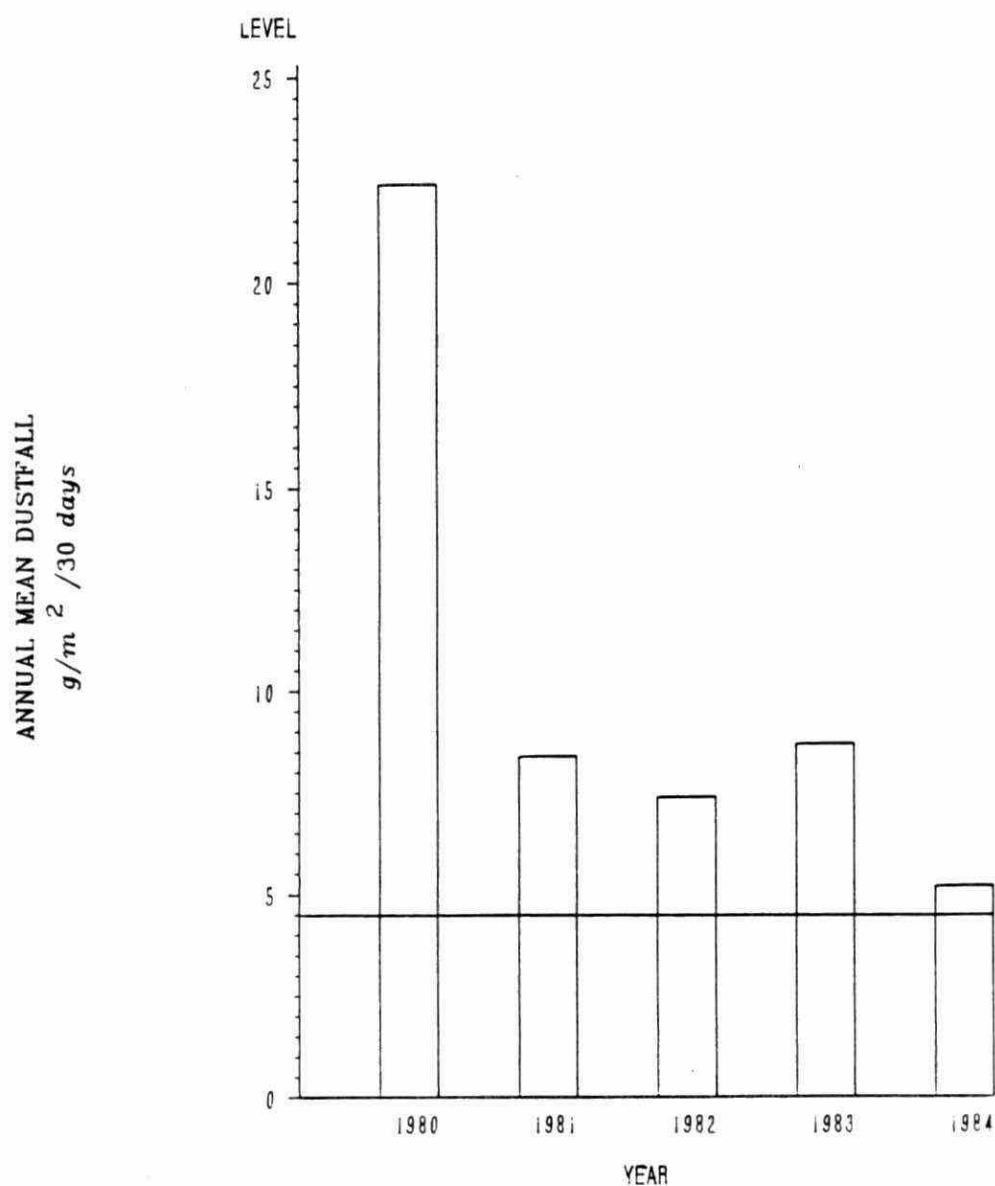
ANNUAL MEAN DUSTFALL LEVELS COLLECTED
SOUTH OF HWY.11, STATION 72059 KAPUSKASING
FROM AUGUST, 1980 TO DECEMBER, 1984



PROVINCIAL CRITERION
 $4.5 \text{ g/m}^2 / 30 \text{ days (1 Year Period)}$

FIGURE 8

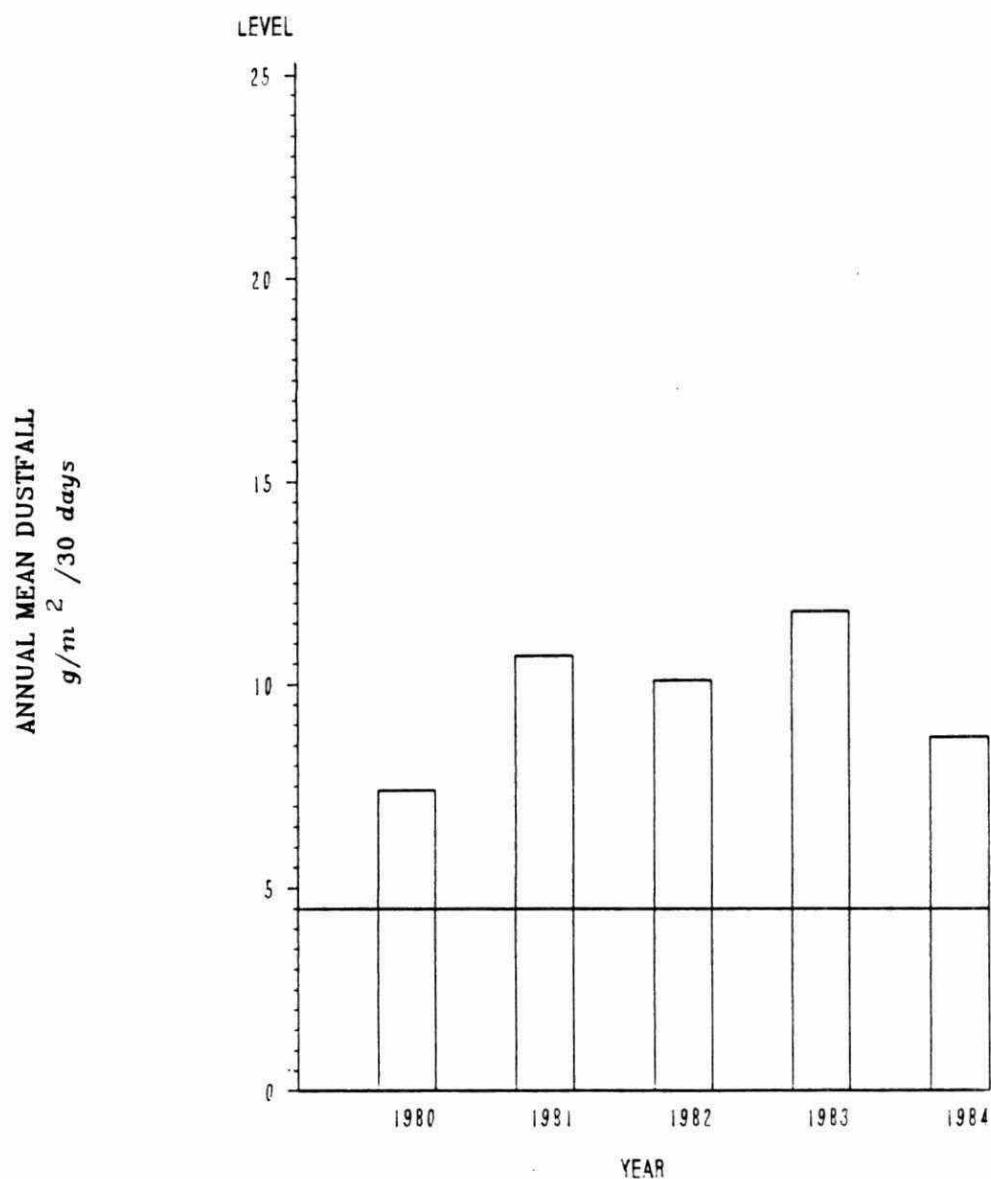
ANNUAL MEAN DUSTFALL LEVELS COLLECTED AT
2 McPHERSON AVE., STATION 72060 KAPUSKASING
FROM AUGUST, 1980 TO DECEMBER, 1984



PROVINCIAL CRITERION:
 $4.5 \text{ g/m}^2 / 30 \text{ days (1 Year Period)}$

FIGURE 9

ANNUAL MEAN DUSTFALL LEVELS COLLECTED AT
4 RIVERSIDE DRIVE, STATION 72061 KAPUSKASING
FROM AUGUST, 1980 TO DECEMBER, 1984



PROVINCIAL CRITERION:
 $4.5 \text{ g/m}^2 / 30 \text{ days}$ (1 Year Period)

FIGURE 10

ANNUAL MEAN DUSTFALL LEVELS COLLECTED AT MILL STREET, STATION 72062 KAPUSKASING FROM AUGUST, 1980 TO DECEMBER, 1984

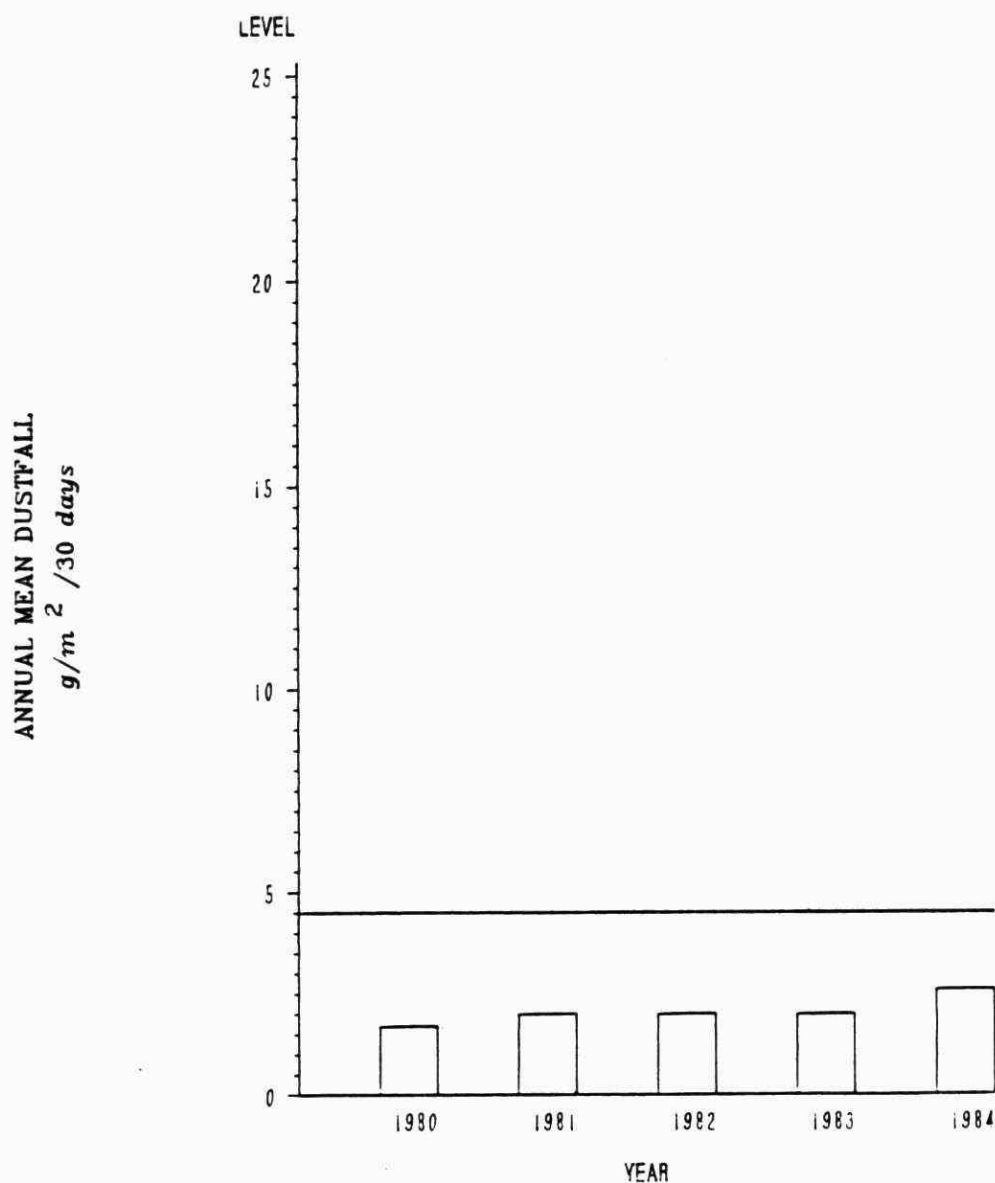
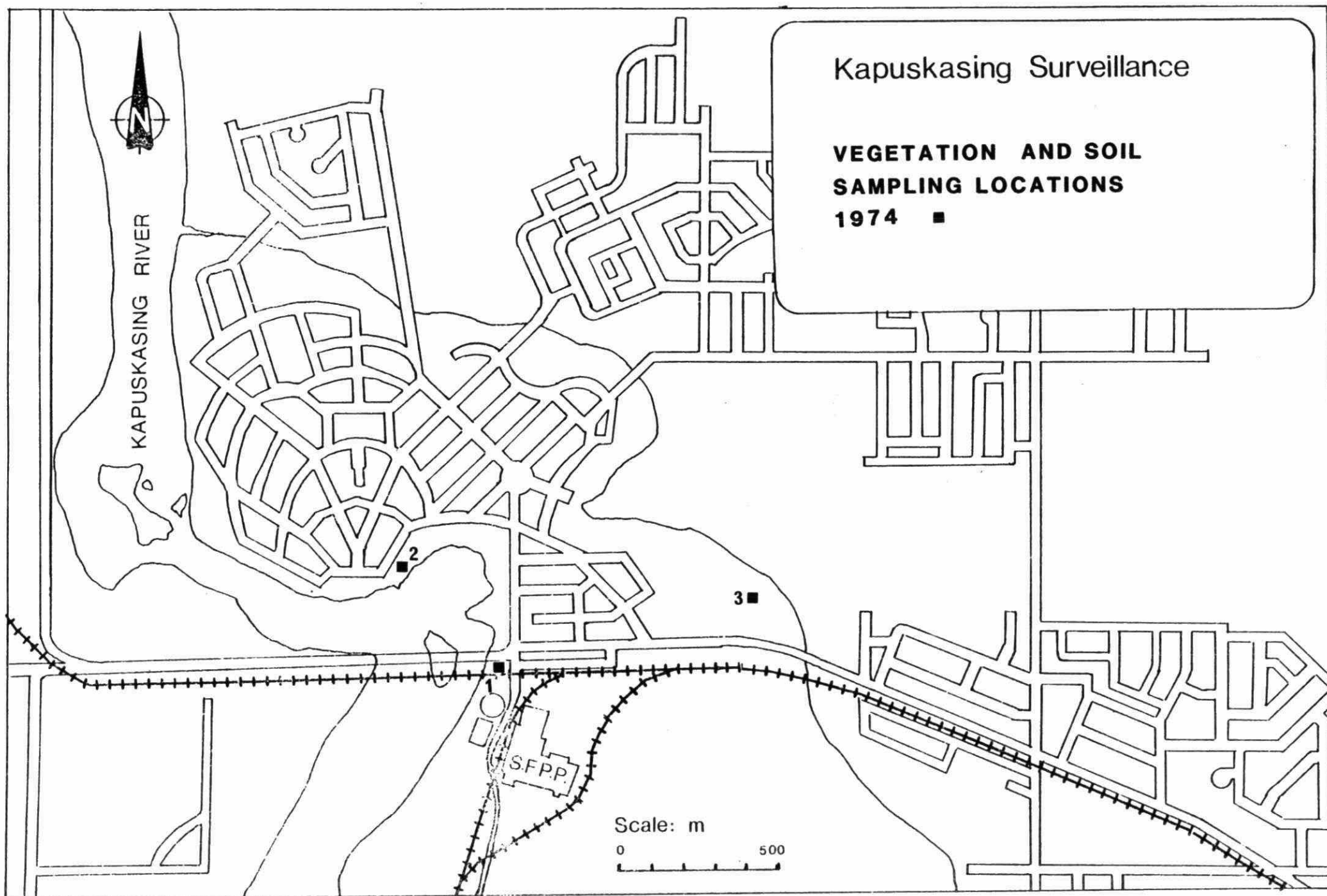


FIGURE 11

FIGURE 12



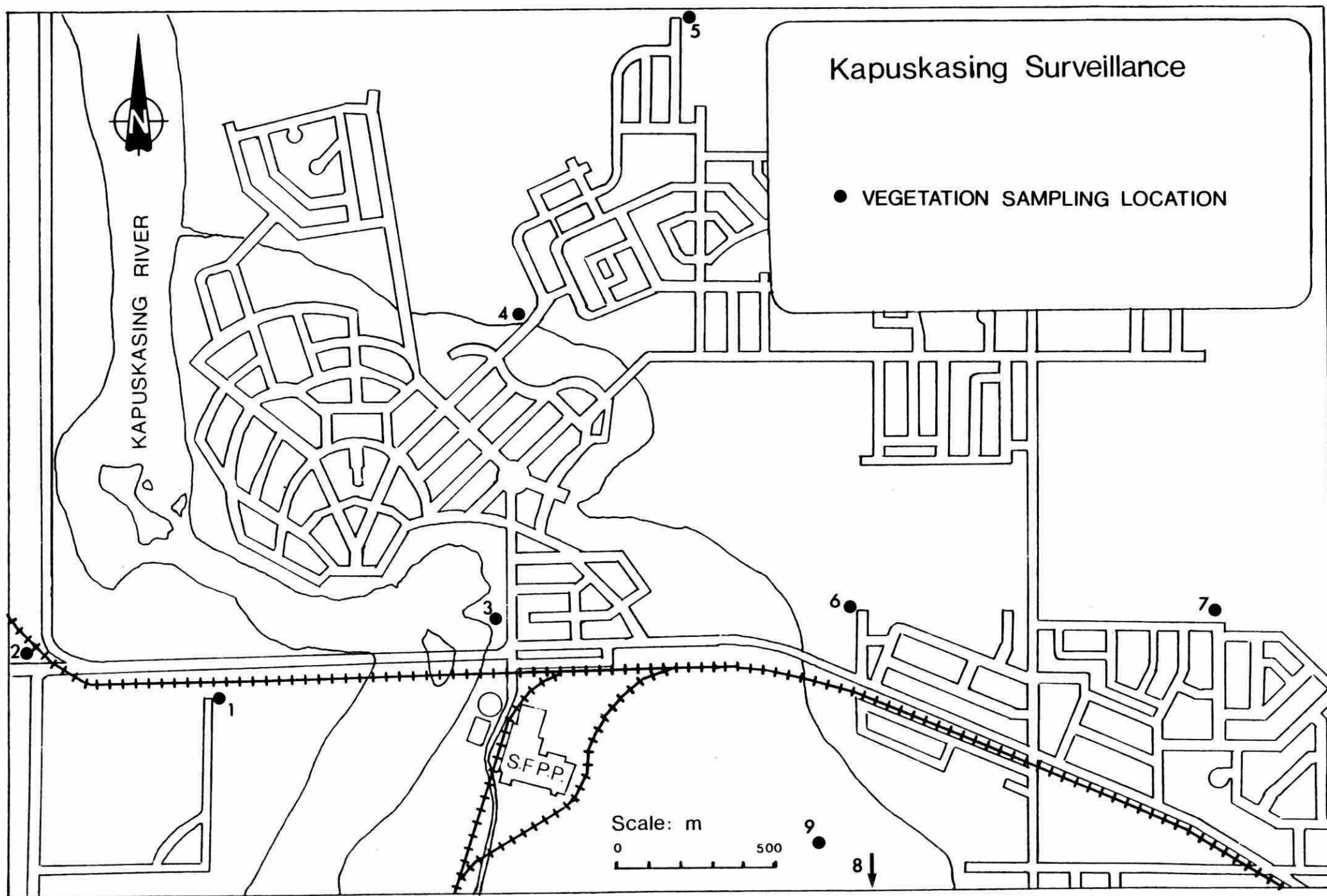
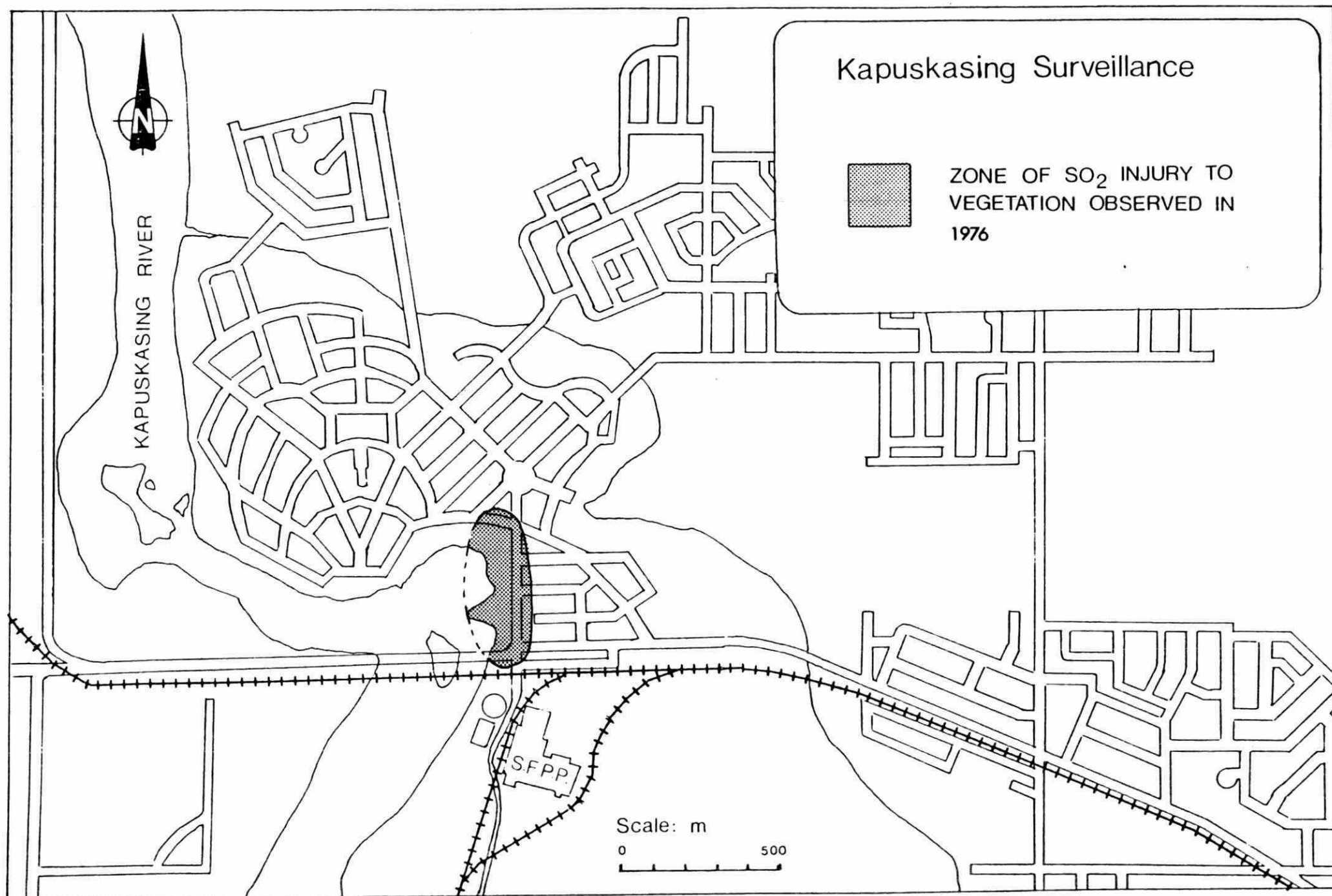


FIGURE 13

FIGURE 14



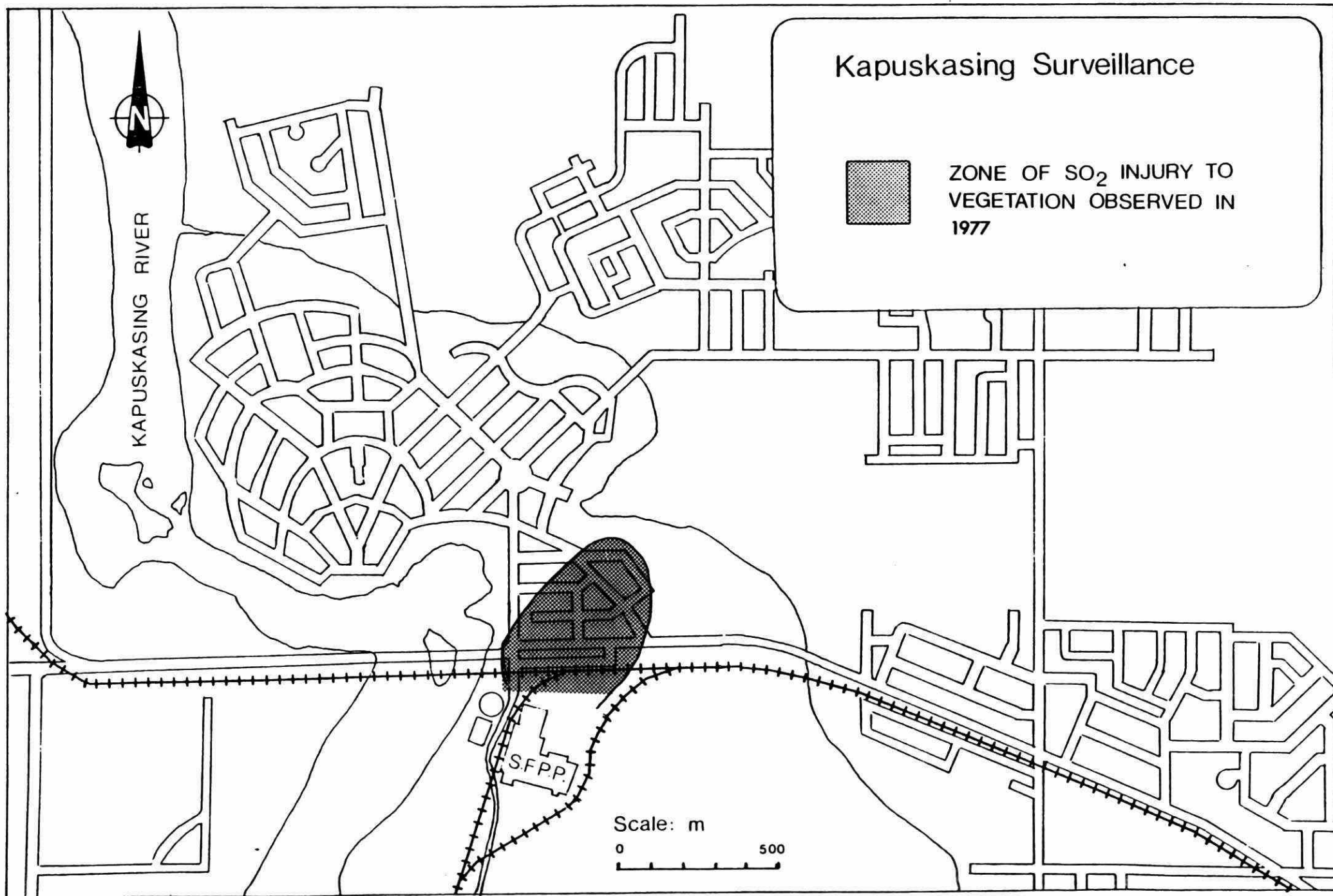


FIGURE 15

FIGURE 16

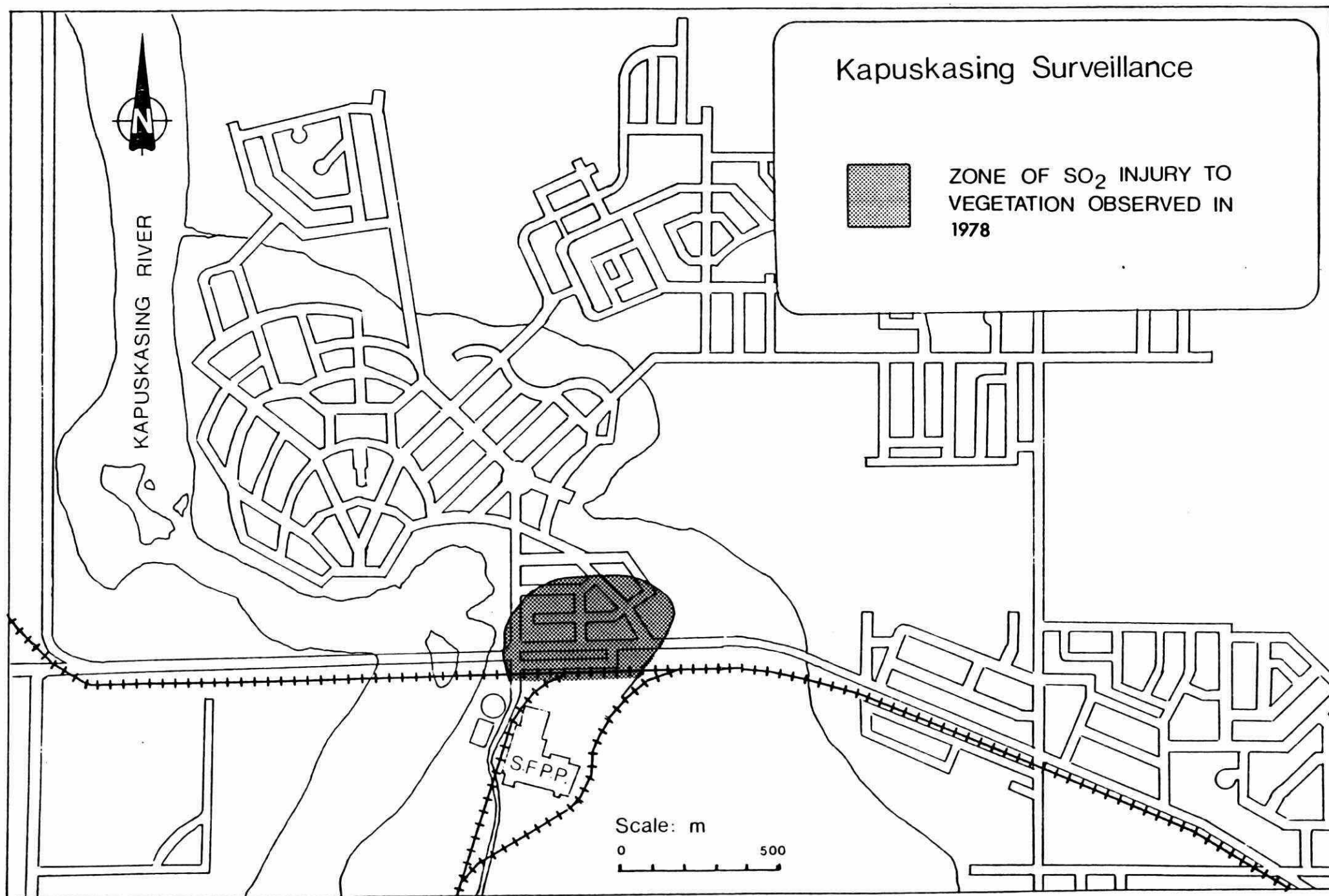
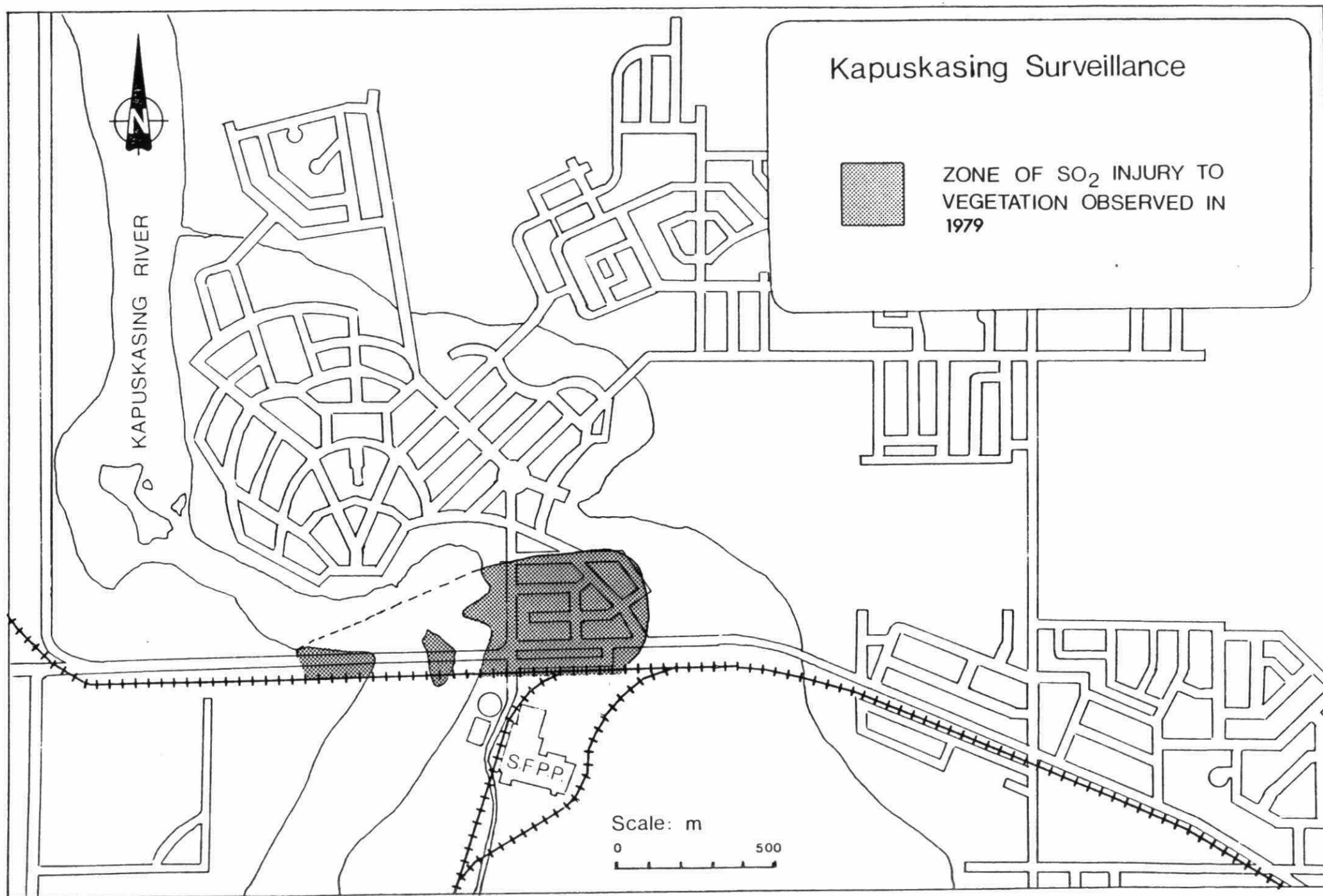
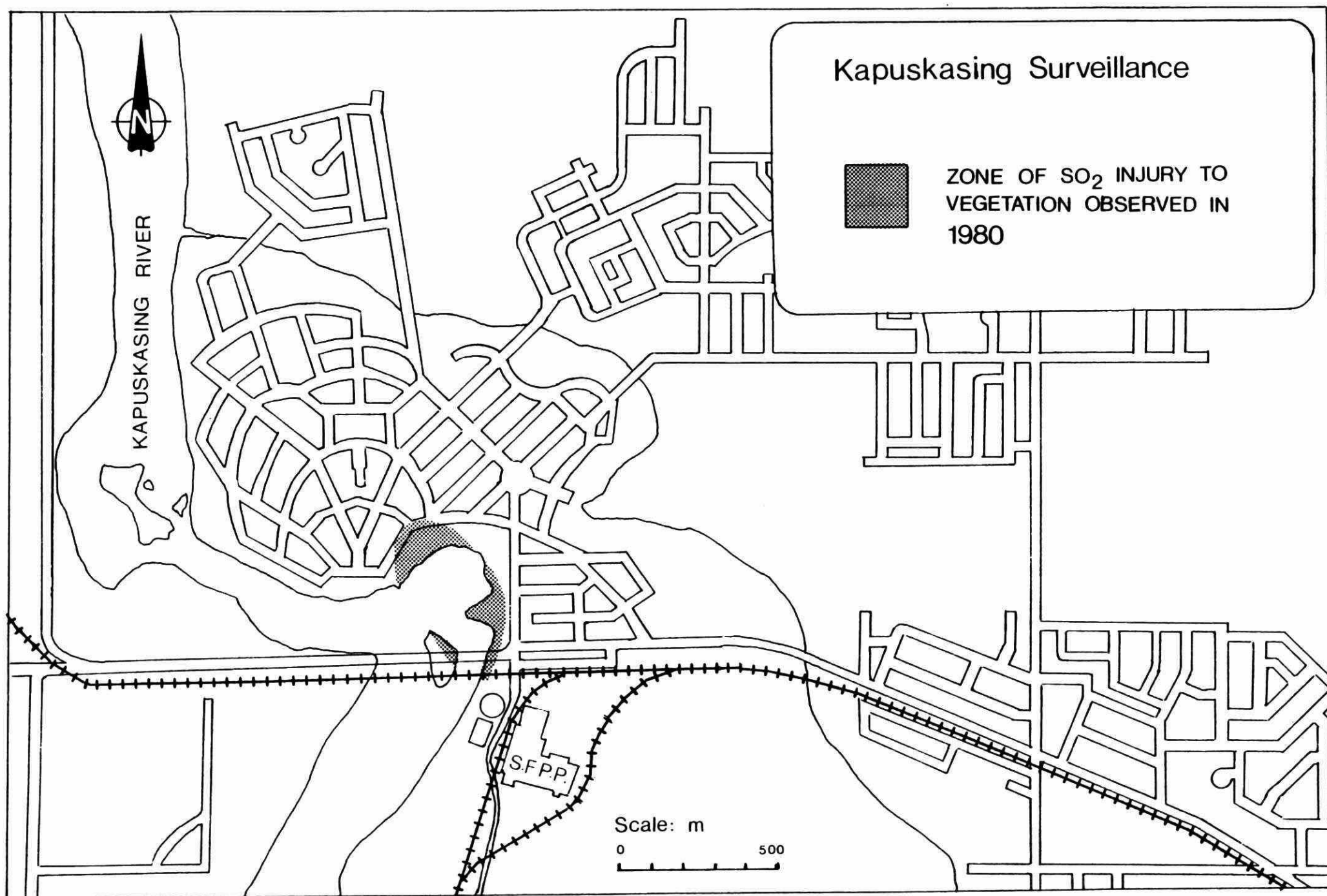


FIGURE 17





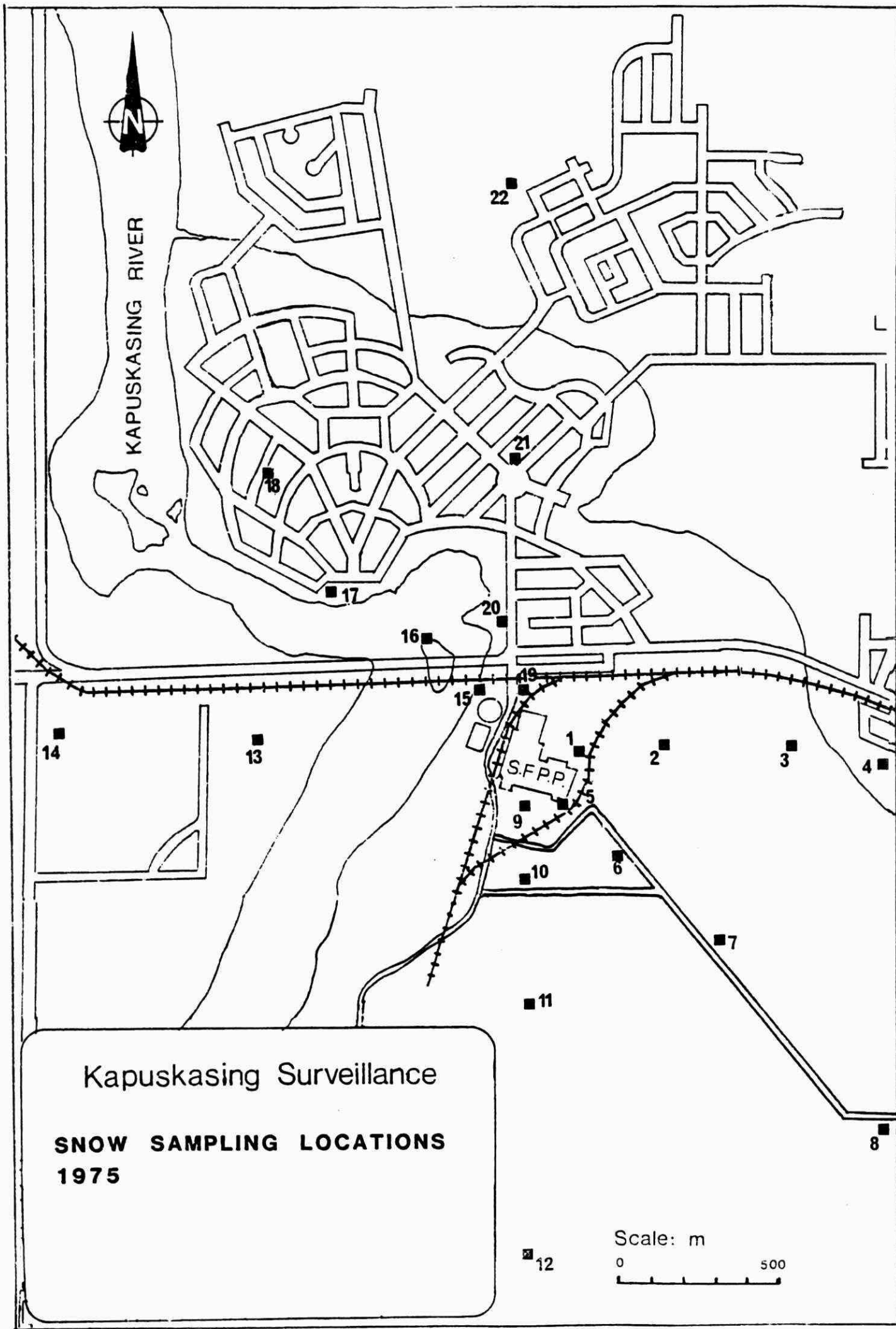


FIGURE 19

APPENDIX C

Sulphation Rate Monitoring

Sulphation rate is measured by exposing small plastic plates coated with lead peroxide (PbO_2) to the atmosphere for 30-day periods. The PbO_2 reacts with gaseous sulphur dioxide to form lead sulphate. The quantity of sulphate formed is analytically determined and reported as milligrams of sulphur trioxide (SO_3) per hundred square centimetres of exposed PbO_2 impregnated material per day ($\text{mg SO}_3/100 \text{ cm}^2/\text{day}$). The method is normally used to detect the presence of sulphur dioxide, but other reactive sulphur compounds, such as H_2S may also be converted to the sulphate form.

The Provincial criterion for sulphation, outlined in Ontario Regulation 296, is $0.7 \text{ mg SO}_3/100 \text{ cm}^2/\text{day}$ for a 30-day exposure.



Dustfall Monitoring

Dustfall (total) comprises of larger, more visible, particulate matter which settles out from the atmosphere by gravity. It is measured by exposing an open top plastic jar for approximately 30 days.

The total amount of dustfall is determined by weighing the contents of the jar and expressing the results in $\text{g/m}^2/30\text{-days}$.

The settleable particulate collected in the dustfall jar can be separated into a soluble and an insoluble fraction for further analysis. The insoluble portion can be examined using an optical microscope to determine the composition of the particulate.

Although this method of sampling can be variable and is dependent on external factors such as wind and the amount of rain and/or snowfall during the sampling period, it is very useful in determining the amount of settleable particulate in the atmosphere.